U.S. Department of Transportation
National Highway Traffic Safety Administration

ODI RESUME

Investigation: EA 02-021
Prompted By: PE01-042
Date Opened: 09/06/2002 Date Closed: 11/06/2003
Principal Investigator: TOM BOWMAN
Subject: FRONT SUSPENSION U-BOLTS LOOSEN OR BREAK

Manufacturer: VOLVO TRUCKS NORTH AMERICA, INC.
Products: VOLVO TRUCK NORTH AMERICA (VTNA) VN MODELS 1996 - 2003*
Population: 93,842

Problem Description: ALLEGEDLY, THE 20 MM COARSE THREAD FRONT SUSPENSION U-BOLTS LOOSEN AND/OR BREAK, WHICH COULD CAUSE LOSS OF VEHICLE CONTROL

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	11	0	11
Crashes/Fires:	0	0	0
Injury Incidents:	0	0	0
# Injuries:	0	0	0
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	1153	1153

*Description of Other: VTNA WARRANTY CLAIMS FOR FRONT SUSPENSION U-BOLTS AS OF MAY 2003

Action: CLOSE THIS ENGINEERING ANALYSIS. A SAFETY RELATED DEFECT TREND HAS NOT BEEN IDENTIFIED.

Engineer: *Thomas Bowman* Date: *10/29/2003*
Div. Chief: *Richard Boyd* Date: *11/06/2003*
Office Dir.: *Kathleen C. DeMeter* Date: *11/06/2003*

Summary: ODI'S investigation did not find any evidence that loose or broken front suspension U-bolts have caused or contributed to any crashes or "near miss" events. See the attached engineering analysis report for full technical details.

* 1996/1997 built vehicles are designated by Volvo as 1998 model year.

faxed
11/6/03

U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

400 Seventh Street, S.W.
Washington, D.C. 20590

Closing Report – EA02-021

Alleged Front Suspension U-bolt Failures (fracture, torque loss, stretching, or continuous loosening) in 1998 – 2003 model year (*) Volvo Truck North America (VTNA) VN Model Highway Tractors

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(*) VTNA designated vehicles manufactured from 1996 through 1998 as "1998 Model Year" vehicles

BUCKLE UP AMERICA

NHTSA
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DOT AUTO SAFETY HOTLINE
888-DASH-2-DOT
888-327-4236

EA Number: 02-021 Date Opened: 06-Sept-02 Date Closed:

(1) SUBJECT

Alleged front suspension U-bolt failures (fracture, torque loss, stretching, or continuous loosening) in 1998 – 2003 model year Volvo Truck North America (VTNA) VN model tractors.

At the initiation of this investigation, ODI identified six VTNA tractor models identified as "Day Cab," 420, 610, 660, and 770 models manufactured from 1996 through 2001. VTNA designated this group of vehicles as the "VN" Model. VTNA also designated VN models manufactured from 1996 through 1998 as "1998 model year" vehicles.

In May 2003, VTNA advised ODI that VTNA had released six new vehicle model designations that were identical in the front axle suspension but differed in other aspects of the vehicle's design. The following table summarizes that complete list of potentially affected vehicle models manufactured over the suspect production period (from initial production in 1996 to 2003).

Initial Vehicle Model Designations (1996-2002)	Successor Model Designations (as of 2003)
Standard or "Day" Cab	200 & 300
420	430
610	630
660	670
770	780

(2) BASIS

On March 21, 2001, the OOIDA (Owner-Operator Independent Drivers Association) filed a petition (DP01-003) requesting the Office of Defects Investigation (ODI) to investigate a number of alleged defects in certain 1998-2000 heavy truck vehicles manufactured by Volvo Trucks North America (VTNA). Front suspension U-bolt integrity (fracture, torque loss, stretching, or continuous loosening) was one of several OOIDA complaint items identified in the petition.

On December 5, 2001, ODI initiated Preliminary Evaluation PE01-042 to investigate front suspension U-bolts after reviewing the complaint information summarized in the OOIDA petition.

On July 30, 2002, ODI completed a "sister" investigation, EA01-011, of U-bolts installed in the rear suspensions of VTNA VN Model tractors manufactured between 1996 and 2000. EA01-011 concluded that the 20mm (approximately 3 / 4") coarse threaded U-bolts installed in the rear suspensions appeared to provide a marginal clamp for the requirements of the rear suspension application, but that subsequent loosening or breakage did not result in any loss of control events. EA01-011 was closed without a finding of a safety defect.

On September 2, 2002, ODI initiated EA02-021 to investigate the front suspension U-bolt clamp for VTNA VN Models tractors based on two potentially-related crashes and the possibility that the 1,107 front suspension U-bolt warranty claims (submitted to VTNA as of February 2002 and provided to ODI in response to ODI's Information Request) might be indicative that the front suspension U-bolts could be an issue for concern.

Summary of Performance Information at EA Inception (September, 2002)

	ODI	Manufacturer	Total
Complaints	(*) 11	0	(*) 11
Crashes	2	0	2
# Injuries	0	0	0
Warranty	0	1107	1107

(*) ODI resumes PE01-042 and DP01-003.5b list four complaints that describe a fracture of the front suspension U-bolt and three reports that describe a loosening condition. The remaining four reports offer ambiguous complaint descriptions.

The 11 complaint reports provided to ODI did not provide detailed technical information and/or vehicle service history information.

The front suspension U-bolts from the two potentially related crashes were discarded soon after the alleged crashes. Consequently, ODI was not able to inspect those U-bolts to determine whether or not they may have contributed to the reported crashes.

(3) POPULATION

Following is a summary (all models combined) of the suspect vehicle population. This population consists of VTNA tractor models designated "Day Cab," 200, 300, 420, 430, 610, 630, 660, 770, and 780.

Calendar Year	Registered Units (*)
1996	59
1997	5829
1998	16455
1999	19433
2000	19596
2001	11646
2002	11898
YTD Sept, 2003	8926
Total	93842

Source: VTNA reported 1996 – 1999 production in an IR response letter to ODI dated December 6, 2000. VTNA provided ODI with updated production volumes for years 2000-2003 on October 1, 2003. (*) "Registered units" identifies vehicles that have been registered for warranty (i.e., put into service). "Registered units" exclude unsold vehicles residing in plant or dealer inventories.

(4) DESIGN HISTORY AND ISSUES

The front suspensions in VN model tractors are equipped with dowels that maintain the positioning of the axle, suspension blocks, and springs relative to each other in the front suspension. Four front suspension U-bolts provide the clamp force that retains the axle, suspension blocks, and springs into a rigid assembly.

According to VTNA, the front suspension components and the characteristics of the U-bolt (physical properties and installation practices) have remained essentially unchanged since their initial production usage in 1996.

The family of U-bolts that have been installed in various configurations of the VTNA VN models front suspensions consists of six different U-bolt part numbers. These front suspension U-bolts are identical in leg spread, thread specifications and material properties. They differ from each other only in the lengths of the U-bolt legs.

In February 2002, ODI sent Information Requests to peer manufacturers. The responses indicated that U-bolts are commonly used to retain the front suspension components in line haul tractors. The front suspension systems used by the peer manufacturers appear to be similar to the VTNA suspension, but vary from each other in individual design details.

Front suspension joint integrity is dependent on a number of component, loading, environment, and maintenance factors. Each of these factors and/or combination of factors creates opportunities for variability in the joint integrity. In addition to the properties of the individual components such as U-bolts, the mating flat washers, tapered plates and nuts, the integrity of the clamp joint depends the flatness, surface finish, parallelism, alignment, coatings and cleanliness of the various individual components in the suspension assembly. The frequency and quality of preventive maintenance and the magnitude, direction, and frequency of the forces imposed on the front suspension joint are additional sources of variation in clamp joint integrity.

In addition to the above listed sources of potential variability, the front suspension U-bolts used by VTNA and peers vary in size, shape, length, material properties, and assembly practices. Since these variations make peer comparisons of U-bolt performance a potentially complex exercise, ODI has not pursued design comparison, but has used the peer information as reference for warranty rate comparison (Appendix B), comparative maintenance recommendations, and to add perspective to understanding the specific front suspension U-bolt symptoms (or complaints) that VTNA owners encounter (as reflected in the warranty claims).

(5) METHODOLOGY

In order to determine the character and scope of this issue,

(1) ODI conducted phone interviews with several VTNA vehicle owners who had filed complaints with ODI through OOIDA. These interviews were intended to obtain a better understanding of the nature and details of the complaints directly from complaining consumers and to determine their maintenance awareness and practices.

(2) ODI sent Information Requests to manufacturers of peer vehicles to determine what types of performance issues (complaints) have been reported with front suspension U-bolt systems and field experience. ODI found that complaint levels vary among the manufacturers; that all have experienced reports of loosening and breakage; and that problems are frequently detected by drivers who perceive noises such as "popping" or by service technician's inspections.

(3) ODI conducted a survey of major fleets at the inception of this investigation in April 2002 and again in June 2003 at the completion of this investigation. ODI contacted fleets that operate a large number of VTNA VN model tractors by both phone and e-mail to assess fleet experience with the front suspension U-bolt performance.

Data from fleets is useful because fleets generally maintain comprehensive maintenance records and operate a large number of tractor units in fleets that provide information about a significant and concentrated number of the population under investigation. Frequently, fleets also operate peer tractors and provide some comparative performance perspectives.

The ODI survey found that the large fleet users surveyed have maintenance procedures or policies for the front suspension U-bolt system; that maintenance practices vary according to individual fleet preferences; and that front suspension U-bolt problems are negligible. (See Appendix A).

(4) ODI reviewed VTNA warranty claims to determine the nature of front suspension U-bolt complaints and compared the claim rates to equivalent warranty records from peer manufacturers. The warranty claim rate for front suspension U-bolts varies significantly from manufacturer to manufacturer, which could be due to design, manufacturing, and quality differences but could also be attributable to unrelated issues such as differences in the individual company's warranty policies.

(5) ODI conducted on-site inspections of four VTNA tractors that had been in single vehicle crashes. ODI selected crash vehicles in which the U-bolts were found fractured after the crash. The purpose of the inspections was to determine whether the U-bolt breakage might have been a factor in the crash.

ODI did not find any evidence that U-bolts had caused or contributed to any of the crashes investigated.

List of Crashes inspected by ODI in which the VTNA Front Suspension U-bolts had been found fractured in the post-crash wreckage. All crashes were single vehicle incidents.

Inspection Number	VIN s/n	Model Year	Crash Date	Crash Location	Inspection Date	Incident Description
1	N797027	1999	July 3, 2001	Cocke County, TN	August 20, 2002	Vehicle departed 4 lane divided interstate highway to left from left (passing) lane, crossed median culvert, crossed oncoming traffic lanes, and went through a guard rail into a ravine
2	N794879	1999	April 3, 2002	Beaver, UT	September 18, 2002	Vehicle departed a four lane divided highway to the left into the median and rolled 1/4 turn onto its right side
3	N791735	2000	April 4, 2002	Fairfield, TX	April 9-10, 2002	Vehicle hauling loaded tanker trailer departed four lane divided highway to the right, rolled ¼ turn onto right side.
4	N318309	2001	October 16, 2002	Deming, NM	April 29-30, 2003	Vehicle departed the right lane of a four lane divided highway to left and rolled 3/4 turn to the right in the highway median.

Shaded cells indicate that the crash resulted in one or more fatalities.

Appendix C contains copies of ODI inspection reports from Inspections # 1, 2, and 4. The U-bolts were removed from the vehicle inspected listed in Inspection # 3 and shipped to Packer Engineering who performed an examination of the removed U-bolts and issued a metallurgical report on May 22, 2002. Appendix C also contains excerpts from the Packer Engineering report.

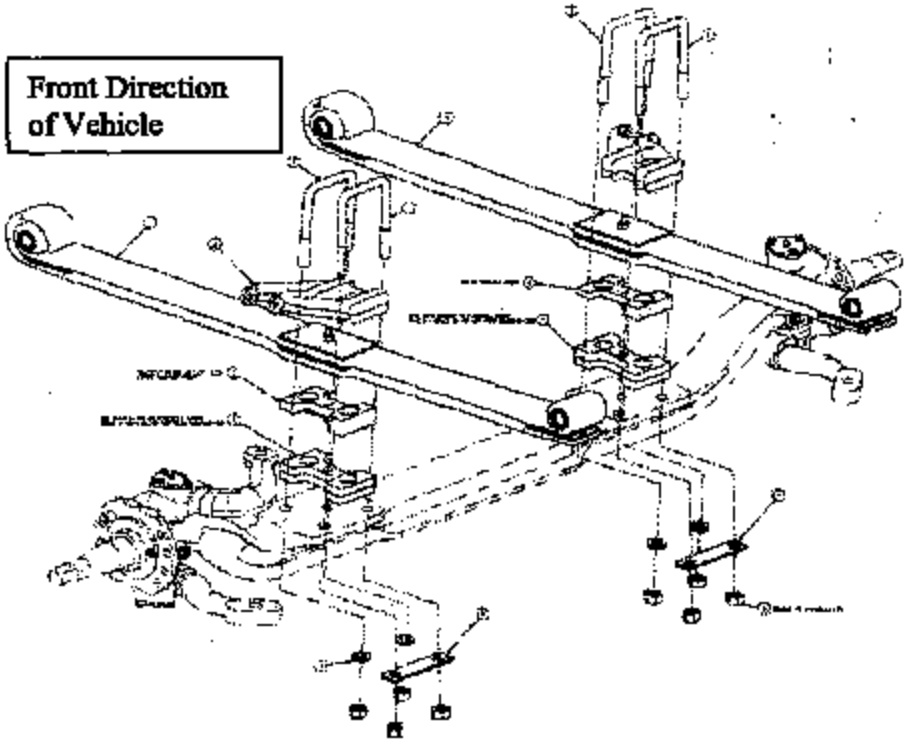
(6) DESCRIPTION OF SYSTEM AND DISCUSSION:

Each front suspension of the 1996-2003 VTNA VN model vehicles is equipped with four 20mm diameter (approximately 3/4"), Grade 10.9 U-bolts. According to VTNA, the dimensional, material, and process specifications for the front suspension U-bolt has remained essentially unchanged since VTNA began installing this series of U-bolts in production vehicles in 1996.

ISO 898-2 (Table A.1) specifies that Grade 10.9 fasteners should have a nominal tensile strength of 1000 N/mm^2 (145,000 psi).

Each of the four U-bolts installed in the front suspension of the subject VTNA tractor has two right angle bends that form the "U" shape. Each U-bolt is installed laterally over the shock absorber bracket with one leg of the U-bolt going through the suspension mounting pad bored into the front axle on the inboard side of the spring assembly and the other leg of the U-bolt installed in a similar manner on the outboard side of the spring assembly. The U-bolt achieves clamp by tightening nuts that are threaded into the each of the two ends of the U-bolt.

Exploded View of the VTNA VN Model Front Suspension Assembly

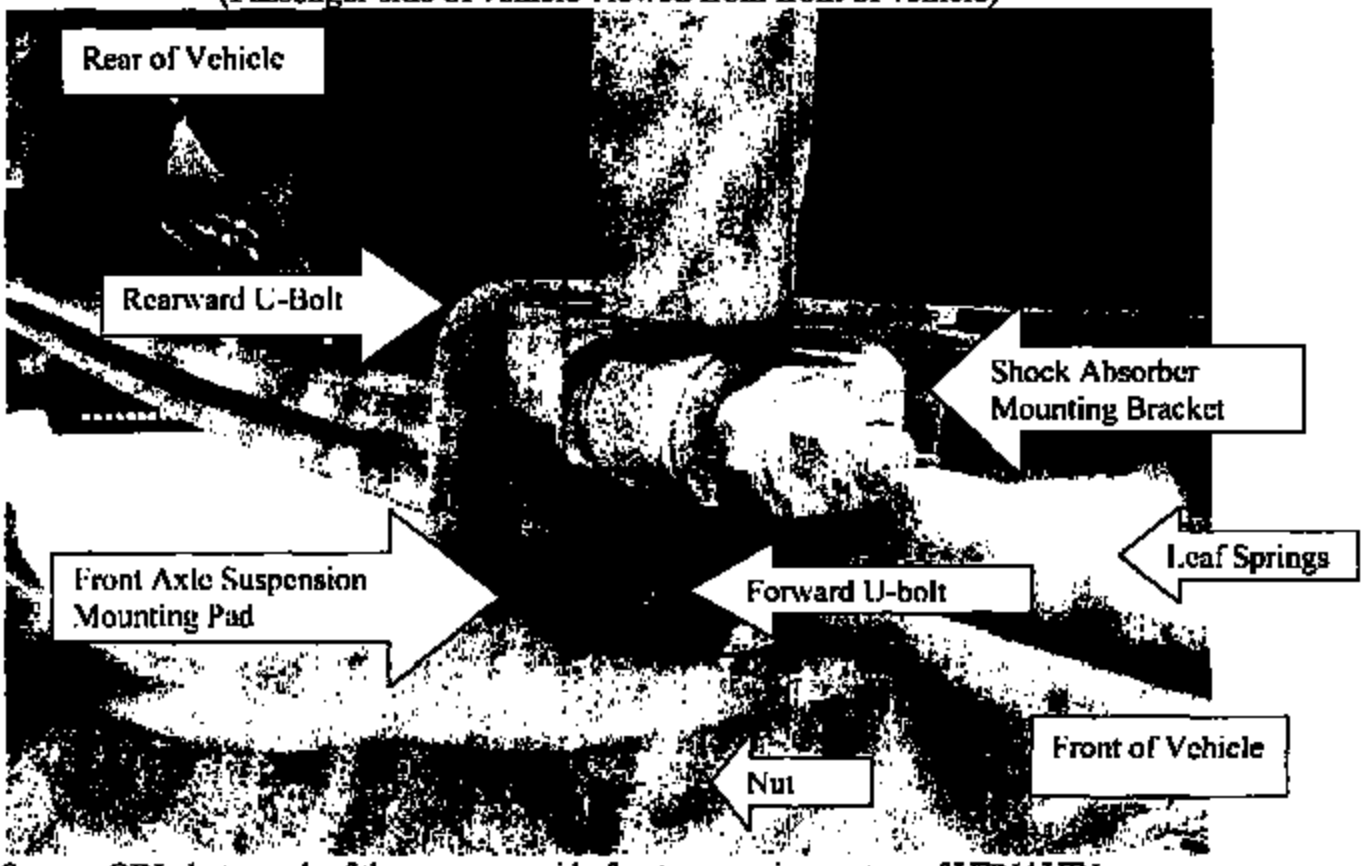


Source: VTNA Engineering Drawing 8080317 provided to ODI on May 20, 2003 in response to an ODI Information Request. ODI has edited the sketch for this report.

Flat washers are installed between the lower face of the front axle suspension mounting pads and the U-bolt retaining nuts in the forward U-bolt positions. A tapered rectangular plate is installed between the lower face of the front axle mounting pad and the U-bolt retaining nuts in the rearward U-bolt positions. Each of the two tapered plates is approximately 1-1/2 inches wide by 6-3/4 inches long and is equipped with two holes.

The following photograph provides a view of an assembled front suspension, axle and U-bolt retention system.

Photograph of representative VTNA "VN Model" Front Suspension Retention System
(Passenger side of vehicle viewed from front of vehicle)



Source: ODI photograph of the passenger side front suspension system of VTNAVIN 4V4NC9JH51N317996 on April 30, 2003, taken at the Ryder facility in Albuquerque, NM.

During operation of the vehicle, axle to suspension U-bolts loosen as U-bolts stretch and as uneven axle, spring, and shock absorber bracket surfaces (high spots, paint, and coatings) fret, wear and seat against each other when exposed to service-induced loads.

ODI has described the alleged defect as "fracture, torque loss, stretching, or continuous loosening of the drive axle U-bolts." To clarify the focus of this investigation, during operation of the vehicle, a suspension U-bolt will stretch elastically in response to clamping torque that is applied to the mating nut. The U-bolt returns to original length when the torque is relaxed if the clamping torque is kept within this elastic range. ODI is concerned only about incidents in which U-bolts have "stretched" plastically and therefore have deformed and do not completely return to their original length when the torque is relaxed.

It is normal for U-bolts to lose some amount of clamp through service-induced loading especially early in the vehicle life when the suspension parts are "seating." It is normal for a U-bolt to require some tightening to compensate for the decrease in clamp.

Most heavy truck front suspensions are equipped with four U-bolts --- two on the right side and two on the left side --- of the axle. In order for the axle positioning to be affected by a loss in U-bolt clamp, both of the U-bolts installed on the same side of the axle must lose their capability to retain the axle in its intended position in the suspension.

Though specific servicing recommendation details vary among manufacturers, all major U.S. manufacturers recommend that suspension U-bolts be (1) tightened early in the vehicle life and (2) inspected and/or re-tightened at regular intervals thereafter

If only a single U-bolt is loose or broken, the axle positioning will not be significantly affected. A more serious condition could develop if a single loose U-bolt condition is not detected and corrected because the remaining U-bolt installed in the same side of the suspension is then subjected to additional loads since it must compensate for the loss of clamp formerly contributed by the first U-bolt. These additional loads will hasten the loosening of the second U-bolt. If the second U-bolt loosens, stretches or breaks, the suspension's ability to retain the axle in its intended position in the vehicle is compromised. If the axle shifts from its intended position in the suspension, vehicle control may be affected.

The Federal Motor Carrier Safety Administration (FMCSA) requires that, before a driver drives a motor vehicle, the driver shall be satisfied that the motor vehicle including parts and accessories is in safe operating condition. Front suspension components are included in the list of items to be inspected. At the completion of each day's work on each vehicle operated, the driver is required to complete a report that covers various parts and accessories. Prior to driving, the driver is also required to review the last driver vehicle inspection report prepared on that vehicle.

(7) SUMMARY OF FINDINGS

ODI's investigation has determined that the following issues are relevant to this investigation:

MAINTENANCE SENSITIVITY

Suspensions require periodic inspection and may require re-tightening periodically due to the inherent potential for U-bolts to loosen as the suspension components retained by the U-bolt clamp seat against each other under service-induced loads.

ODI interviews of fleet operators who operate large numbers of VTNA tractors indicate that operators who follow basic maintenance practices do not experience significant U-bolt integrity problems and are able to detect looseness through routine inspection methods or driver "feel." Many fleets use simple inspection methods that are focused on detecting pre-indicators of looseness (rust, shiny metal, etc.), which indicate that parts are moving (shifting and chafing) relative to each other.

VTNA asserts that mechanics that have not followed the recommended inspection and tightening maintenance protocols are a major factor for U-bolt performance problems. ODI has found evidence to support VTNA's position from several ODI interviews of owner operators (non-fleet) who were unaware of the published maintenance recommendations.

SAFETY ASSESSMENT PARAMETERS: FREQUENCY, DETECTABILITY, AND SEVERITY

FREQUENCY

As a part of this investigation, ODI has examined warranty information from both VTNA and peer vehicle manufacturers. ODI is aware that comparing manufacturing warranty rates must be done with caution since warranty conditions (terms) and administration policy may vary significantly among manufacturers. Certain manufacturers may offer limited warranty, no warranty, or allow policy payments under special circumstances. The duration of warranty coverage may also vary among manufacturers and warranty policies may change over time. Some manufacturers may be rigorous in the application of warranty policy, whereas others may be more generous. Some manufacturers may keep warranty records that reflect denied claims, whereas others do not. The more important use of the warranty and field complaint information was to identify vehicle owners whose reported experiences appeared to indicate that the U-bolt failure event might have posed a possible risk to safety, which enabled ODI to investigate these events more thoroughly.

Appendix B summarizes the warranty rate analysis. This analysis is not a part of the body of this report because the information was analyzed early in the investigation and because this warranty rate analysis did not offer significant value to the investigation.

DETECTABILITY

VTNA claims that problems with U-bolt integrity are due to long term effects of inadequate inspection and improper maintenance. VTNA also recommends that owners regularly conduct routine maintenance, and re-torque when indicated, at 15,000 mile or three-month intervals.

ODI has found that certain non-fleet users are unaware and/or frequently fail to perform, the recommended U-bolt inspection. Several of these owners have suggested that the 15,000 miles inspection interval is unreasonable.

ODI has also found that many mechanics employ various inspection techniques such as examining the U-joint areas for "rust runs" or "shiny metal" as an indication that parts are shifting relative to each other or using a hammer strike on the saddle bracket to check the tightness of the U-bolt clamp. It appears that these methods are useful to experienced mechanics to detect indications of loosening U-bolts, but that some operators are less familiar with inspection methods and/or what indications might be indicative of a loosening condition in the suspension.

SEVERITY

ODI has assessed the severity of the safety risk by examining four crashes in which the front suspension U-bolt had been found fractured after the crash and in which the circumstances of the crash indicated that there was potential that the front suspension U-bolt may have been a factor contributing to the crash.

These inspections did not provide any evidence that indicated that any of the crashes have been caused by or associated with front suspension U-bolt loosening or breakage.

(8) INDICATIONS OR WARNINGS

SYMPTOMS THAT BOLTS HAVE LOOSENED OR BROKEN

Loose or broken front suspension U-bolts are frequently detected through visual inspections or the driver's "feel" (sense that a change has occurred in the vehicle ride quality). Warranty claims indicate that front suspension U-bolt problems are frequently preceded by some degree of audible warnings caused by components shifting under load when a looseness condition has developed.

(9) VTNA ACTIONS

VTNA has implemented an advisory program to inform owner-operators and second-generation owners about appropriate maintenance for front suspension U-bolts, as well as other aspects of vehicle maintenance. This information will be available on the VTNA website.

(10) CONCLUSIONS

ODI has found that the design configuration of the "subject vehicles" appears to be comparable with peer vehicles.

ODI has reviewed 1153 VTNA warranty claims (submitted to VTNA as of May, 2003), 40 VTNA customer call reports, and investigated four vehicle crashes. ODI selected these crashes for further examination because the front suspension U-bolts had been found fractured in the post-crash wreckage and, therefore, represented a high potential for obtaining information as to whether or not a problem had developed in the front suspension U-bolt clamp integrity in the crash vehicle prior to the crash. ODI did not find any evidence through these inspections that indicates that fractured U-bolts caused or contributed to these vehicle crashes.

The number of warranty claims for front suspension U-bolts provide ODI with a basis for concern but the descriptive information contained in the warranty claim reports, information obtained from interviews with major fleets, and evidence from the crash vehicles, has not provided any evidence that the front suspension U-bolts installed in 1998-2003 VTNA VN model tractors have failed to perform as intended.

This investigation is closed. The closing of this investigation does not constitute a finding by NHTSA that no safety-related defect exists. The Agency will take further action, if warranted, in the future.

G. T. Bowman, Safety Defects Engineer — Date: 10/29/03

I Concur:

Chief, Medium & Heavy Duty Truck Division — Date: 11/6/03

Director, Office of Defect Investigation — Date: 11-6-03

APPENDIX A

Summary of Survey Regarding U-bolt Concerns
Among Major Fleet Users of 1998-2003Model Year Tractors
(& EA 01-011)

ODI contacted major fleet users of 1998-2003 VTNAVN Models tractors. ODI contacted the listed fleets in January 2001 during the initial phases of this investigation and again in June 2003 at the final phase of this investigation. These surveys have indicated that major fleet users follow inspection and maintenance procedures and have not experienced any significant problems with the front suspension U-bolts. This sampling reflects the performance of 8594 tractors.

Fleet & Contact	Number & Vintage of VTNA Tractors	Experience	Summary of Maintenance Practice & General Comments
Roadway Express	1621 Units (MY 2000 - 2003)	None	Visual inspection for rust or visible defect at 25,000 miles intervals. Visual at driver pre-trip inspections or noted while driving
American Freightways	4027 Units (MY 1998- 2003)	"...never seen problems nor breakage on the front axle suspension"	Driver pre-trip and post trip inspections. Preventive Maintenance at 36,000 mile intervals. Drivers and technicians inspect for rust streaks, movement, shiny metal, etc that are out of the norm.
Watkins Motor	798 Units (MY 1998 – 2003)	"non issue"	Torque checked at initial preventive maintenance interval; visual thereafter.
Yellow Freight	2148 Units (MY 1998 - 2003)	"none"	Visual inspection every 15,000 miles; torque wrench check every 70,000 miles

APPENDIX B

Warranty Claim Rate Comparison – VTNA and Peers

Front Suspension U-bolt Warranty Rate (per 100,000 vehicles)
Based on Warranty Data provided in March, 2002

OEM	1996	1997	1998	1999	2000	Total
Volvo	**na**	**na**	**24.07**	**29.48**	**11.15**	**20.41**
International	40.56	27.37	19.52	11.43	6.96	16.47
Freightliner	4.88	4.80	2.93	3.51	1.66	3.54
Peterbilt	1.17	1.74	2.43	1.88	3.33	2.16
Mack	2.37	.13	.46	.23	.72	.87
TOTAL	4.85	10.01	6.47	5.53	3.14	5.29

Warranty claims were summarized by the model year (vintage) of the vehicle. Warranty rate was determined by dividing the warranty claims by the associated model year of vehicle production regardless of the mileage or time in service at the time of the claim.

APPENDIX C

ODI Inspection Reports of Selected Crash Vehicles

ODI INSPECTION REPORT

VTNA VIN 4V4ND1GH4YN797027

August 20, 2002

INSPECTION REPORT – VOLVO VIN 4V4ND1GH4YN797027
August 20, 2002

Introduction -

On August 20, 2002, Tom Bowman (ODI), Jim Hague (VRTC), and Thad Gardner (TRC) inspected a 1999 vintage Volvo Tractor, VIN 4V4ND1GH4YN797027.

The purpose of the inspection was to make a preliminary evaluation of the post-wreck vehicle to determine whether it appeared likely that a vehicle component malfunction, especially in the front suspension system, may have contributed to the single vehicle fatal crash that occurred on July 3, 2001 in Cocke County, Tennessee.

Background -

In July 2002, an attorney representing the family of an owner operator who was killed in the crash provided ODI with a series of photographs that were taken on August 8, 2002 approximately 37 days after the crash. The photographs consisted of (1) various views of the roadway near or at the scene of the incident as well as (2) photographs of the tractor and trailer which had been taken at a separate location after the crash.

Prior to the August 20 inspection, ODI independently obtained a set of photographs provided by Bridge Terminal Transport, the owner of the trailer. ODI also independently obtained a set of photographs that were taken immediately following the July 2 crash from the Tennessee State Police. In preparation for the vehicle inspection, ODI reviewed the photographs and formed some preliminary observations that are outlined in Appendix III of this report.

Photo Group	Provided By	Date Photos Taken	Subject of Photographs	Comments
# 1	Tennessee State Police	July 2, 2001	Vehicle at final resting point taken the day of incident	Photocopies of TSP photographs
# 2	Bridge Transport	July 3, 2001	Vehicle roadway with tire marks, tractor and trailer at salvage yard,	
# 3	Attorney	August 8, 2001	(A) Incident Site photos (B) Vehicle photographs taken after removal from incident site	Photos taken 37 days after incident; a number of tire marks were left by salvage and road repair vehicles, not incident vehicle
# 4	ODI	August 20, 2002	Vehicle and vehicle components, especially the front axle suspension components	Photos taken more than a year after the incident and after the post-crash vehicle had been moved twice

According to family members, the vehicle had been towed to the site near Dickson, TN approximately 4 months after the incident and 8 months prior to the August 20, 2002 inspection (i.e. in approximately December, 2001).

Photographs groups # 1 and # 2 are more valuable for evaluating tire tracks, skid marks, etc. since the photographs in group # 3 had been were taken approximately 37 days after the incident and the original crash-incident vehicle tracks have been obscured by tire tracks from salvage and road repair equipment.

Vehicle Condition and Circumstances at August 20, 2002 Inspection -

The vehicle was situated in an open area unprotected from the elements.

Only the tractor had been transported to Dickson. The trailer and cargo container were not there. The tractor had been moved at least twice after the crash: once to an interim location near the crash site where it resided for an estimated 4 months and then to Dickson, TN where it had resided for an estimated 8 months.

Inspection confirmed that the VIN of the inspected vehicle matched the VIN shown in earlier photographs and identified in the July 2, 2001 police incident report. The appearance of the vehicle is also consistent with the vehicle that appears in the earlier-provided photographs.

Crash Summary -

Post incident photographs taken on-site and witness accounts indicate that the vehicle departed the roadway to the left, through the median, across the oncoming lanes, and into and through the opposite lane guardrail.

Based on the details of the incident, there are four significant opportunities for the vehicle to have experienced the damage that was observed:

(1) Departing the road into the median culvert
(2) Striking and penetrating the opposite lane guardrail
(3) Impacting the base of the ravine
(4) During vehicle removal and transportation

Visit to Incident Site, Cocke County -

Following the vehicle inspection, Tom Bowman visited the scene of the crash. Visual inspection (supported by photographs on file) indicate that shoulder of the median is sufficiently steep that it would be difficult for an operator to return a vehicle to its original lane of travel after that vehicle had left the roadway to the left and entered the downward slope of the median shoulder. Observations from this inspection are included in Appendix I.

Volvo VIN 4V4ND1GH4YN797027 taken August 20, 2002 (ODI)

The tractor had been partially overgrown with brush as shown in the above photograph.

General Vehicle Damage -

The tractor had been extensively damaged. The front axle was separated from the vehicle suspension and the engine appeared to have been dislodged from its mounting.

(1) The left (driver's side) of the tractor indicated significant damage:

- the left side of the chassis had been bent inward
- the left rear frame had been bent inward
- the steering gear shaft (internal to the gearbox) which is mounted in the left side of the vehicle had been bent inward
- the steering shaft (external connection between the steering gearbox and the steering wheel) ha d been bent and separated
- the steering gearbox input yoke had been fractured through its bore
- other significant and varied damage was observed but are too numerous to list

The left side damage is consistent with a large force applied to the left side of the vehicle and is consistent with a vehicle rolling on its left side (TSP photographs taken immediately after the incident show the vehicle resting on its left side).

(2) The forward right section of the tractor appears to have been displaced significantly rearward. The right side mounted fuel tanks that are mounted on the right side of the vehicle behind the front axle had been crushed rearward.

Greater damage to the forward right side of the tractor compared to the left forward side of the tractor is consistent with a vehicle frontal impact concentrated on the right side of the vehicle.

General U-bolt Discussion -

This report focuses on observations relating to the front suspension U-bolt joint since ODI has conducted this inspection as part of Engineering Analysis EA02-021 that is investigating front suspension U-bolts in Volvo tractors.

Four U-bolts are required to secure the front axle suspension to the axle in this vehicle.

U-Bolt and Front Axle Inspection -

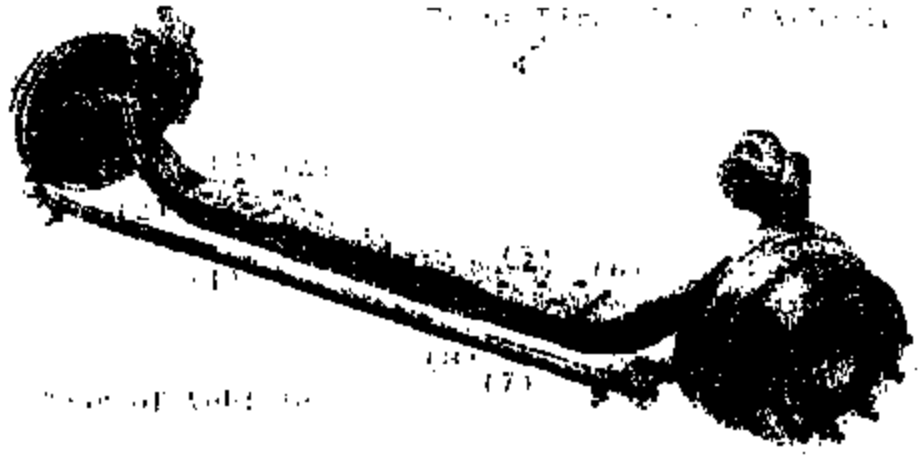
Inspection of VIN 4V4ND1GH4YN797027 found only a portion of a single front axle U-bolt had remained attached to the post-incident vehicle inspected on August 20, 2002 in the outermost rear left side (driver's side) front axle mounting hole. For reporting purposes, this location is identified as U-bolt position # 2.

Although three of the four U-bolts were missing from the vehicle at the time of inspection, the damage observed in the front axle spring pad U-bolt bores (holes) indicated that the missing U-bolts had been installed at some point in time. ODI's inspection of a right side front axle shock absorber bracket, a component in the U-bolt suspension assembly that had been forwarded to ODI separately as a loose component, bore witness marks that indicated both right side U-bolts had been installed at some point in time.

The sketch below (Sketch # 1) provides reference for the location of the front axle suspension mounting bores being described; each of the four U-bolt installation locations has been numbered in a clockwise direction on the sketch for reference. Each of the four U-bolts is installed laterally across the pad: one U-bolt is installed through the forward set of two U-bolt bores and a second U-bolt is installed through the rearward set of two U-bolt bores for both right and left sides of the axle.

Using this sketch as reference, the table below the sketch summarizes the nature and direction of the damage observed at each of the eight front axle U-bolt holes.

Sketch # 1



Source: ODI mark-up of ArvinMeritor publication, SP-95141

U-Bolt Position in Front Axle	Corresponding Axle Beam Holes	Condition of Front Axle U-bolt bore
Left Rear U-bolt	# 1 - Inner Bore	No apparent damage to the bore
	# 2 - Outer Bore	A portion of a broken U-bolt remained in axle bore. See description and observations below.
Left Forward U-bolt	# 3 - Outer Bore	Material from the front axle bore had been displaced in the forward direction
	# 4 - Inner Bore	No apparent damage to the bore
Right Forward U-bolt	# 5 - Inner Bore	No apparent damage to the bore
	# 6 – Outer Bore	Major "lip" of material from the front axle bore material had been displaced in a direction 45 degrees right of forward
Right Rear U-bolt	# 7 Outer Bore	Minor "lip" of material from the front axle bore material had been displaced in a direction 45 degrees right of forward
	# 8 Inner Bore	No apparent damage

As the table indicates, each of the four front suspension U-bolts had left evident impressions (witness marks) in the front axle beam that indicates that all four of the U-bolts had been in position at some time prior to the crash (see shaded cells for description of witness marks). The nature of the witness mark impressions in and around the front axle bores indicates that all of the four U-bolts were displaced due to a single loading event.

It is not possible to obtain evidence from three of the originally installed four U-bolts because these U-bolts had been separated from the vehicle and were not available for inspection. The only U-bolt that remained with the vehicle was a portion of the U-bolt installed in the rear left position of the front axle identified as position #2 in the table and sketch above.

This remaining U-bolt was trapped by the weight of the chassis and could be rotated in the axle bore but not removed from the front axle unless the weight of the chassis was removed from the front axle. The U-bolt fracture face has rusted due to the year-long exposure to the environment and is unlikely to provide much information regarding the nature of the fracture.

Lifting the chassis would require a tow truck or similar equipment. ODI does not plan to remove this U-bolt for further inspection since removal of this U-bolt may be difficult, and possibly dangerous. ODI did not elect to do this because the inspection conducted on August 20, 2002 in conjunction with other information has provided adequate information for the investigation. ODI is satisfied that detailed examination of this U-bolt will not contribute significantly to the information that has already been obtained through the August 20 inspection and noted in this report and from photographs that had been provided to ODI from other sources (identified in the introductory paragraph of this report). ODI believes that expending additional effort to extract the single remaining U-bolt will offer l represents the family of an owner operator who was killed in the crash benefit to this investigation.

The following photograph indicates the position of the single (partial) U-Bolt remaining attached to the front axle. At the time of inspection, the front axle had been completely separated from the suspension. The front axle U-bolts may have separated completely or partially during the incident or after the crash. (ODI does

not believe that the U-bolts were cut or altered by the vehicle salvage process because all four of the front axle U-bolts are shown separated in the on-site post-crash photograph #14 taken by TSP.)

Front of Vehicle

Rear of Vehicle

Photograph of Left side Front Axle Mounting Pad

The front axle spring mounting pad bore (covered by leaf in upper left corner of above photograph) had metal displaced in the forward direction of vehicle travel. If the U-bolt had been loose for any period, the U-bolt bores would have wallowed into an oval form from the various acceleration, cornering, and braking loads imposed in the U-bolt suspension joint. The inspected bores appeared to be round

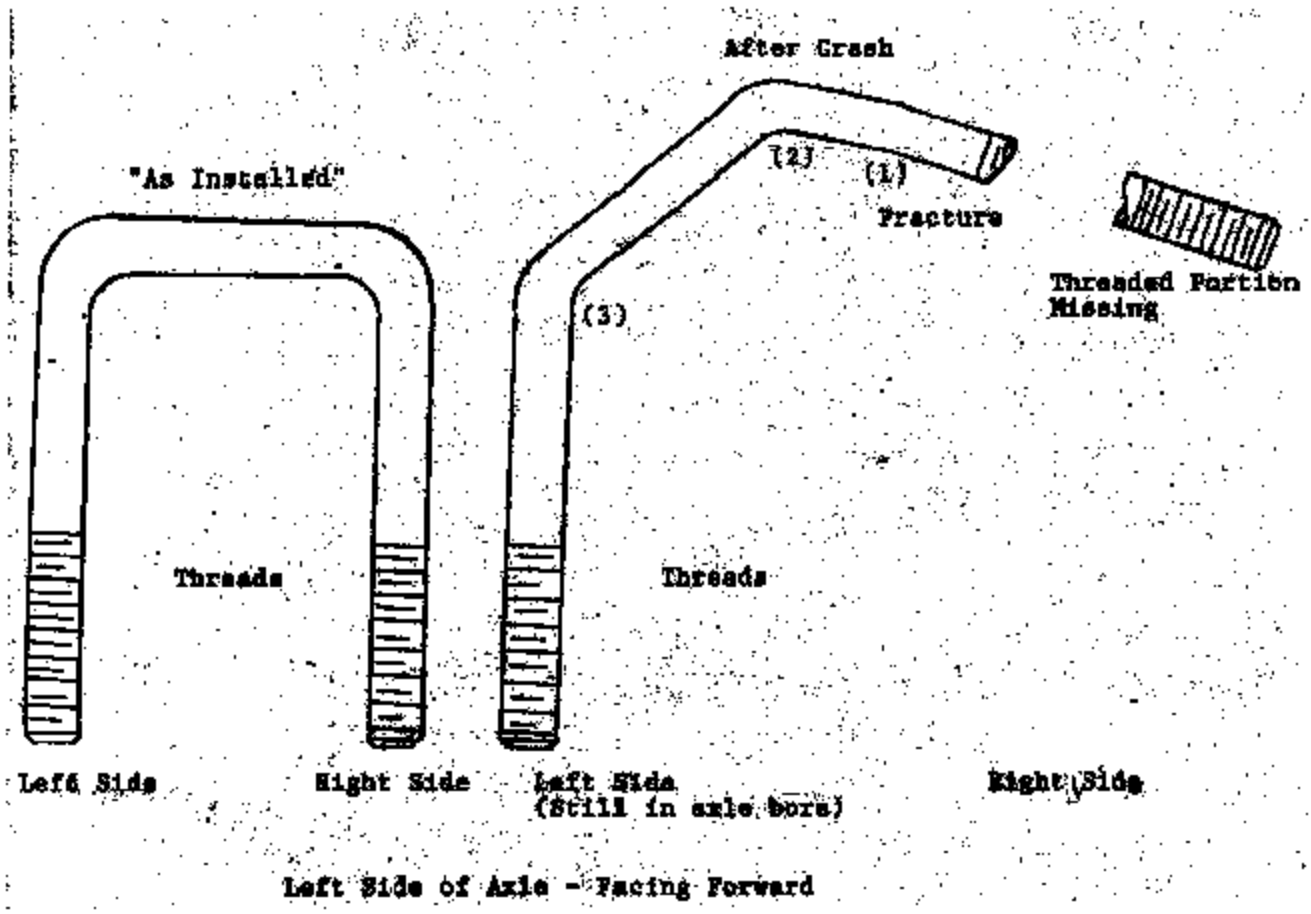
with sharp corners except for the metal that had been displaced in the forward direction indicating that a single large force had been imposed on the joint in the direction of the metal displacement.

The direction of the displaced metal in the left forward position # 3 is consistent with the left side of the front axle making impact with an object in the straight-ahead direction while the direction of displaced metal force in the right forward positions # 6 and # 7 is consistent with the front axle making impact with an object in the a right oblique (or 45 degree in to the right of forward) direction.

The indicated difference in the direction of the load applied to the vehicle left side compared to the right side indicate that the front suspension was subjected to two significant frontal forces that occurred from somewhat different angles.

The right-side bore for the fractured U-bolt is "open" and the portion of the U-bolt that had been installed through this bore had been broken off within a thread or two of the run-out into the U-bolt shank. The fractured piece of the U-bolt was missing and the right hand side of this U-bolt had been bent at three locations:

(1) a slight bend approximately midway on the shank (unthreaded portion) of the right side of the U-bolt.
(2) The right angle bend on the fractured leg has been bent open from the original 90 degree right angle bend to approximately 120 degrees.
(3) The right axle bend on the unfractured leg of the U-bolt has been bent open from the original 90 degree right angle bend to approximately 150 degrees.



ODI believes that the damage to this U-bolt was most likely caused by the following event sequence:

(A) A significant lateral force toward the right side of the vehicle caused the small bend [identified as (1) above] in the right side leg of the U-bolt

(B) The lateral force was so significant that it exceeded the ultimate strength of the U-bolt which then fractured through the right leg. The right leg and retaining nut must have been in place during this loading to provide a reaction force for this significant tensile force. If the U-bolt leg or retaining nut were not in place, it is doubtful that the U-bolt would have been anchored strongly enough to permit a bend to occur at this mid-point in the U-bolt's right side leg.

(C) Once the right side U-bolt leg had fractured, the forces continued to bend the U-bolt out of its original position at locations identified as (2) and (3) in the sketch due to the lateral direction of the forces.

The damage and analysis description is consistent with a vehicle rollover onto its right side.

The mating parts in the U-joint left reasonably clear impressions of the other mating parts indicating that the U-bolt joint had been tight prior to separation. If the U-bolt had been loose, the impression of the mating parts would have a "smeared" appearance caused by relative movement (fretting) of the front suspension springs, the front axle beam, shock absorber bracket, spacers, and U-bolts.

The appearance of unrusted "shiny" metal caused by parts movement might normally provide another indication of a loose joint. However, since the front suspension and U-bolts have been exposed to the elements, ODI has not relied on this indicator.

Other Observations – Wheel Splash Guard -

The right side plastic splash-guard installed in the rear of the wheel well was completely missing from the vehicle; the left side plastic splash guard was found in its normal location and did not appear to have been abraded or damaged.

The vehicle path described by witnesses and confirmed by photographs of the vehicle tire tracks taken at the scene of the crash indicate that the vehicle left the roadway to the left. If a front suspension failure had been responsible for this incident, rearward displacement of the left front wheel would be required in order to be consistent with the details of this incident.

Had the two same-side front axle U-bolts installed in the left side of the vehicle separated before the incident, ODI would have expected damage to the left wheel splash guard from the rearwardly-displaced left front tire. The absence of damage to the left hand splash-guard indicates that the left side of the axle had not been displaced rearward prior to the incident.

If the two same-side right U-bolts had separated or loosened prior to the incident, the vehicle would have departed the roadway in the right side direction. A right hand departure is not consistent with post-incident photograph tire marks or witness accounts.

Front Wheel Splash Guard (grooved plastic liner) installed in rear of left side front wheel cavity. Photo taken facing rearward into wheel cavity

The absence of damage to the left splash-guard indicates that the left front wheel had been not been displaced rearward significantly either prior to or during incident. If the left side front suspension U-joint clamp integrity had separated, or significantly loosened, the left tire would have made contact and left marks on the left wheel splash-guard.

Conclusions -

ODI believes that the front suspension U-bolts fractured as a result of the vehicle impact and that the front axle U-bolt clamp had not been loose and did not contribute in any way to events preceding the incident. There is no evidence of prior loosening or separation as indicated by the inspected condition of the available components. Available evidence from the front axle bores indicates the U-bolts were subjected to a high load event consistent with a frontal impact. There were no tire marks on the left front splash-guard which might be expected if rearward displacement of the left side of the front axle had occurred.

Appendix I – Notes from Incident Site, Bowman visit, August 20, 2002

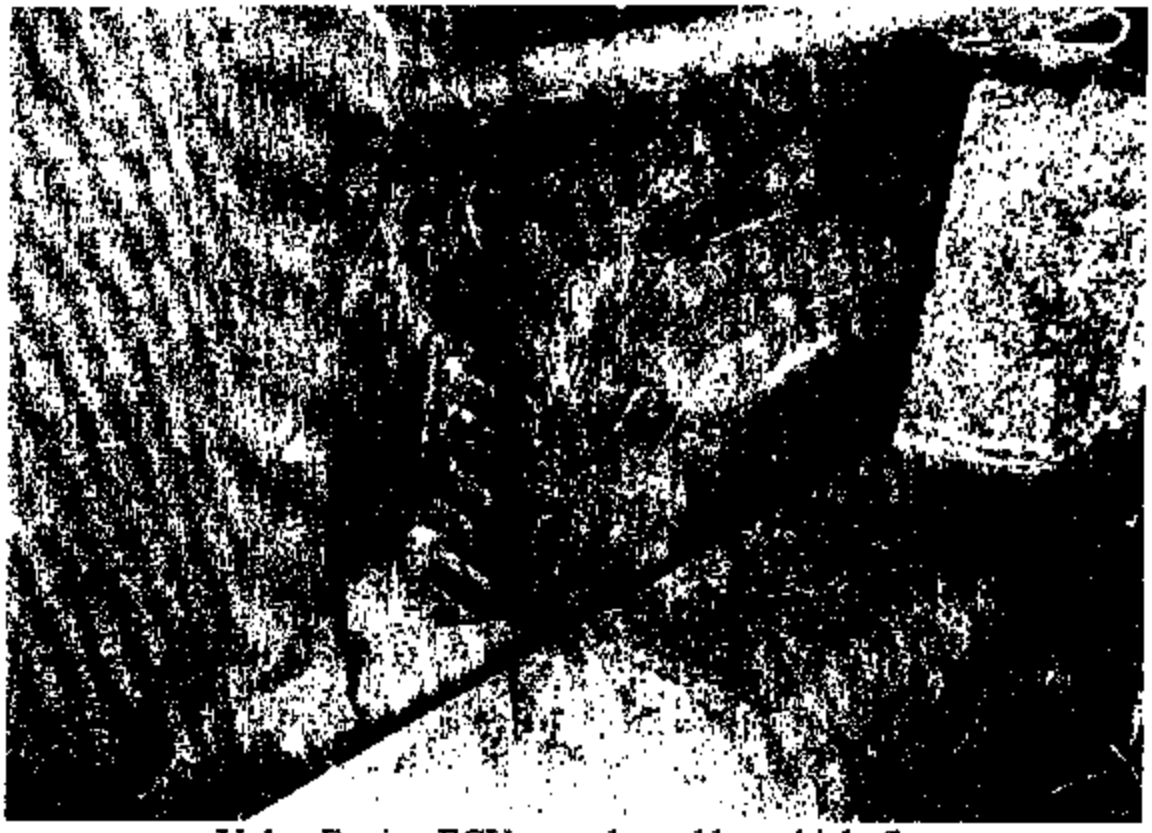
Following are observations from ODI (G. T. Bowman) visit to the incident site on August 20, 2002.

The vehicle was parked and Bowman briefly walked the highway shoulder and median areas where the incident occurred. The inspection was brief due to the risks presented by the high-speed traffic in the area. For this reason, no additional photographs were taken since ODI has many more-relevant photographs on file.

No measurements were taken but some rough visual estimates of the incident environment were made: the center median is approximately 20 feet wide with fairly steep slopes to a depth of approximately three to four feet below the road surface. (The slopes are best depicted photo group # 1, photos 5-8, provided by the TSP.

Appendix II - Other components inspected:

Engine ECU. The engine ECU was inspected to evaluate whether the unit could be removed for the purpose of extracting any retained information regarding the final vehicle operations such as whether the operator performed a brake application, the engine speed at shut-down, etc). Volvo had previously advised that the information available from the ECU would be limited and that no information could be extracted if the unit were cracked or otherwise damaged. Since the engine ECU had been charred by the engine fire, ODI made no attempt to remove the ECU from the vehicle.



Volvo Engine ECU was charred by vehicle fire

Rear Suspension U-bolts. The rear suspension U-bolts were checked for tightness by striking the upper saddle bracket with a mallet. (The mallet was used in lieu of a torque wrench due to the less-than-ideal field conditions for this inspection.) None of the four rear axle U-bolts indicated a looseness condition as might be indicated by any movement in the parts or an audible indication of looseness.

Appendix III - Bowman notes following review of photographs

Vehicle came rest on its left side (photo #15); the front axle was found with the front axle completely separated from the front suspension springs i.e. all of the four U-bolts had separated, most likely during or after the incident.

Tire tracks indicate departure from the roadway to the left; no tire skid marks indicative of vehicle braking were evident at the evident. No evidence of rim marks (possibly indicating a tire failure) on roadway.

TSP Trooper stated that he had searched the incident scene where the vehicle had left the road and through the median culvert but said he did not find that any parts had "dropped" from the vehicle.

GTBowman
9/13/02

ODI INSPECTION REPORT

VOLVO VIN 4VG7DBRJ7XH794879

September 18, 2002

INSPECTION REPORT – VOLVO VIN 4VG7DBRJ7XH794879

September 18, 2002 - Beaver, Utah

Introduction -

On September 18, Tom Bowman (ODI), Jim Hague (VRTC), and Thad Gardner (TRC) inspected a 1999 vintage Volvo Tractor, VIN 4VG7DBRJ7XH794879.

The purpose of the inspection was to make a preliminary evaluation of the post-crash vehicle to determine whether it appeared likely that a vehicle component failure, especially in the front suspension system, may have contributed to the single vehicle crash that reportedly occurred at southbound Mile Marker 95 on I-95 (near Beaver, Utah) on April 3, 2002.

This report focuses on observations relating to the front suspension U-bolt clamp joint since ODI conducted the September 18 inspection as part of Engineering Analysis EA02-021 that is investigating the performance of front suspension U-bolts installed in Volvo tractors.

Background -

On July 30, 2002, an independent Volvo owner-operator sent an e-mail to ODI describing a vehicle that he had observed at Anytime Road Service, 1265 North 300 West in Beaver, Utah. The owner-operator had been aware that ODI was investigating front suspension U-bolts installed in Volvo vehicles and identified the vehicle and its location to ODI for possible investigation value.

ODI contacted the vehicle owner-operator and determined that the owner had purchased the vehicle new and that the vehicle had accumulated approximately 524,000 miles at the time of the crash. The owner's insurance company had determined that the vehicle was to be scrapped rather than repaired.

The owner said that he had received some tickets in the past for being overweight in the front axle GAWR at 12,600 lbs. (Volvo had previously filed a defect notice with NHTSA that reported that some tractors were built at GAWR that exceeded the "plated" front axle GAWR rating.)

Prior to the crash, the driver had left Toronto with the vehicle fully loaded to 79,800 lbs. He spent the first night in LaSalle, Illinois and the second night in Big Springs, Nebraska. He had planned to spend the third night in Periwan, California, approximately 87 miles from the incident site. The driver said he had slept for approximately 10-1/2 hours on the night before the incident and that the weather was clear and dry. The owner further said that he had been driving at approximately 75 MPH in the left hand lane because the left lane provided a better "ride" than the right lane.

Vehicle Condition and Circumstances at September 18, 2002 Inspection -

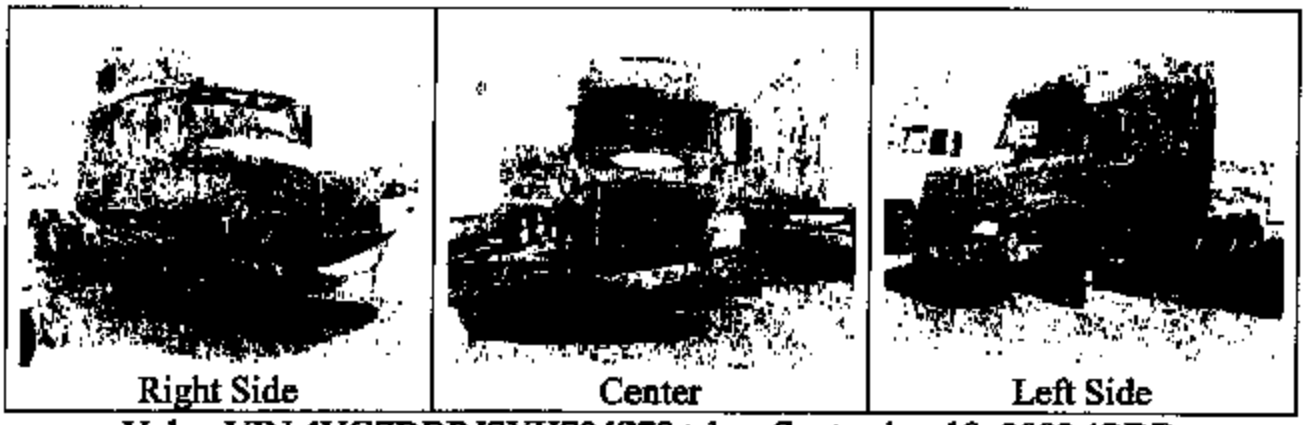
The vehicle was situated in an open area unprotected from the elements. The engine had been removed (and sold) so there was no opportunity to remove the engine control module for possible data download and analysis. The front axle had been removed from the vehicle but was located near the tractor. The front end of the tractor was supported by wood beams where the front axle had been installed. The trailer was also damaged and was parked in the lot next to the Volvo tractor.

Crash Summary -

ODI has not requested a police report and has relied on the phone interview of the vehicle operator for a description of the crash. The driver said that he "felt like he hit a rut" and that "the vehicle took off to the left." According to the driver, the tractor departed the roadway to the left, went through the median area, and rolled to the right when ascending the median in the direction of the oncoming lane of traffic.

General Vehicle Damage -

Viewed from the front of the tractor, the damage was concentrated on the right forward portion of the tractor. There was comparatively little damage to the left side of the vehicle except for the front axle being detached from the springs at the U-bolt connection point. The right side of the tractor had been scraped down the right side of the vehicle body consistent with damage that might be expected when a tractor rolls onto its right side.



Right Side | Center | Left Side

Volvo VIN 4VG7DBRJ7XH794879 taken September 18, 2002 (ODI)

U-Bolt and Front Axle Inspection

Four U-bolts are required to secure the front axle suspension to the axle in this vehicle. Inspection of VIN 4VG7DBRJ7XH794879 found that the major portions of three front axle U-bolts had remained attached to the post-incident front axle inspected on September 18, 2002.

All three of the remaining U-bolts were fractured and bent in a very similar pattern:

(1) The three remaining U-bolts all fractured very close to the thread run-out location into the U-bolt shank of the right leg of the U-bolt

(2) The three remaining U-bolts all exhibited a slight outward bend midway in the shank (unthreaded portion) of the right leg of the U-bolt.

(3) The three remaining U-bolts all exhibited a slight upward bend in the left leg of the U-bolt where it makes a right angle transition bend from horizontal to the vertical left leg.

Similarly appearing damage on these three remaining U-bolts indicates that all of the U-bolts had experienced loads of approximately equivalent magnitude and direction (to the right forward of the vehicle) which resulted in the bends and fractures observed in the U-bolts.

Front of Vehicle

Left Side | Right Side

Photograph showing the front axle and U-bolts from VIN 4VG7DBRJ7XH794879 as found at the Beaver, Utah inspection site.

NHTSA inspectors rotated the U-bolts in place to simulate the inspector's estimate of the approximate positioning of the U-bolts immediately following the crash.

At the time of inspection, the U-bolt installed in the forward left position was missing from the vehicle although witness marks in the axle mounting pad and shock absorber bracket indicated that a U-bolt had been installed at some time. For purposes of this report, this location is identified as U-bolt position # 3 – 4 (see sketch below).

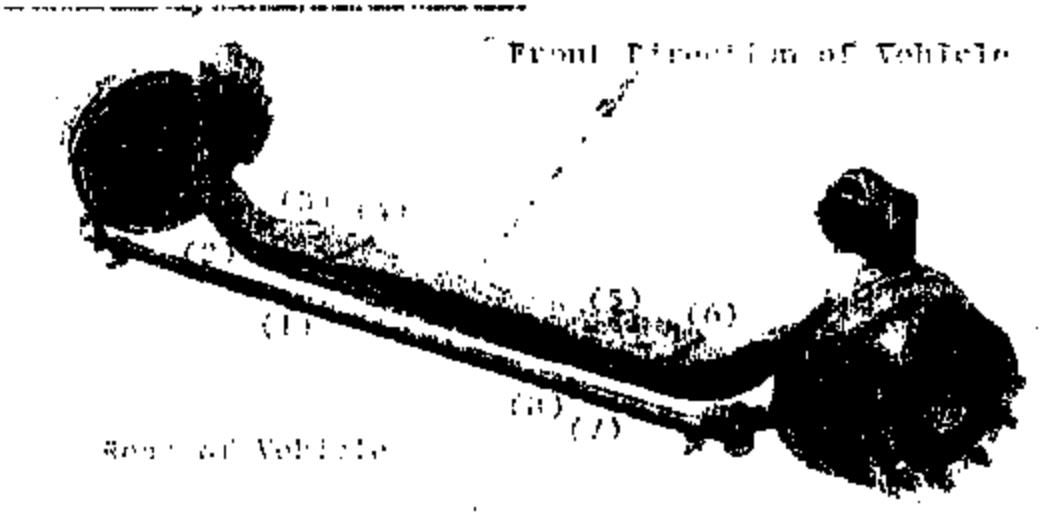
All eight of the axle mounting holes (the bottom-most member in the suspension assembly retained by the U-bolt) and the shock absorber brackets (the topmost member in the assembly retained by the U-bolt) exhibited witness marks which indicated that all four front axle U-bolts had been installed at some point in time.

U-bolts

Each of the four U-bolts is installed laterally across the pad: one U-bolt is installed through the forward set of two U-bolt bores and a second U-bolt is installed

through the rearward set of two U-bolt bores for both right and left sides of the axle.

The sketch below identifies each U-bolt installation location by a number that corresponds to each of the front axle U-bolt mounting bores in a clockwise direction. The table summarizes the nature and direction of the damage observed at each of the eight front axle U-bolt bores.



Source: ODI mark-up of ArvinMeritor publication, SP-95141

U-Bolt Position in Front Axle	Corresponding Axle Beam Bores	Condition of the U-bolt and Front Axle U-bolt bore at the indicated position
Left Rear U-bolt	# 1 - Inner Bore	The bore is "open"; the small threaded fractured "stub" end of the U-bolt that had been installed through this bore is missing.
	# 2 - Outer Bore	The bent and fractured U-bolt was found "hanging" in its bore.
Left Forward U-bolt	# 3 - Outer Bore	The bore is "open" – The U-bolt is missing from the axle.
	# 4 - Inner Bore	The bore is "open" – the U-bolt is missing from the axle.

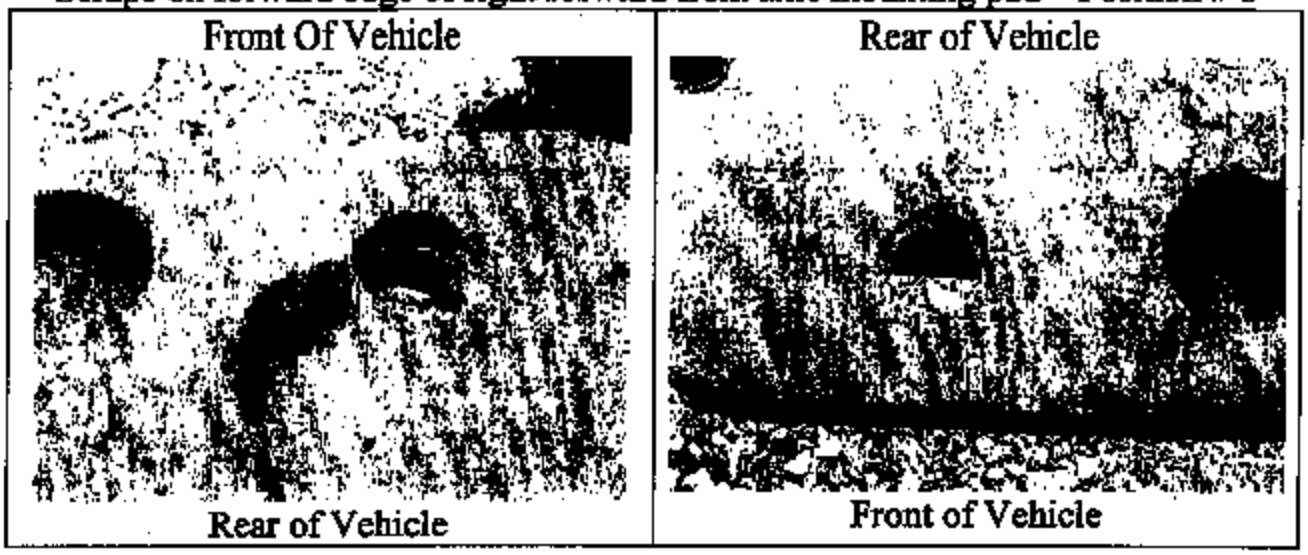
Right Forward U-bolt	# 5 - Inner Bore	The bent and fractured U-bolt was found "hanging" in its bore.
	# 6 – Outer Bore	A scrape observed in the top of the axle mounting face was likely caused by forward rotational displacement of the U-bolt following its fracture. See photo below.

Right Rear U-bolt	# 7 Outer Bore	The small fractured "stub" end of fractured U-bolt was found in the axle bore. The "stub" end indicates the fracture was caused by a force in the forward right direction of the vehicle. See photo below.
	# 8 Inner Bore	The bent and fractured U-bolt was found "hanging" in its bore.

The remaining bolts indicated that they had fractured and were not cut as might have been done to remove the axle from the post-crash vehicle. ODI inspectors removed the remaining portions of the U-bolts from the axle and shipped them to VRTC for further examination.

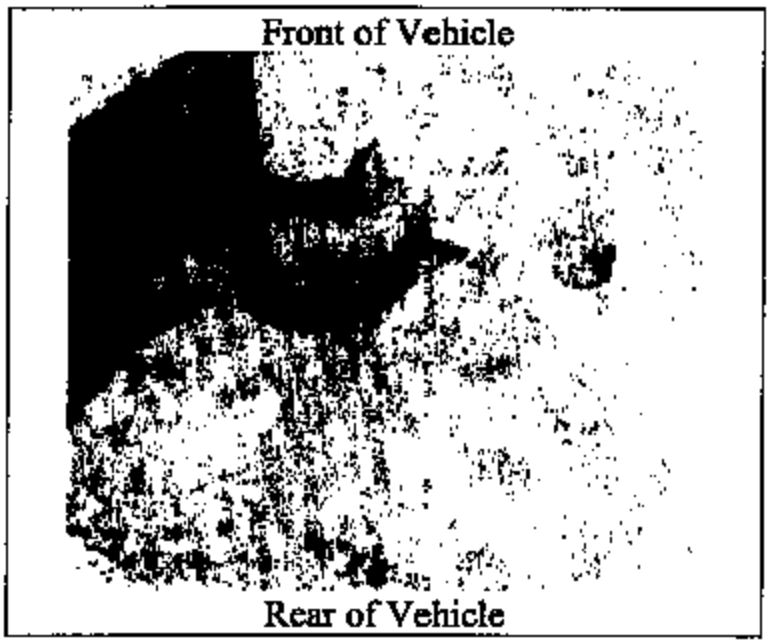
The scrape mark at the forward position on right side forward axle mounting pad surface (Position # 6) is shown in the following two photographs. This scrape mark indicates that the fracture face of the right forward U-bolt had been displaced in the forward direction after the U-bolt fracture. This scrape mark is consistent with the axle being displaced rearward by a significant force acting on the axle from the forward direction while the springs and chassis continue in a forward direction due to their forward momentum.

Scrape on forward edge of right forward front axle mounting pad – Position # 6



Corrosion in the axle mounting bores can also be seen in these photographs.

Broken U-bolt Stub – Position # 7

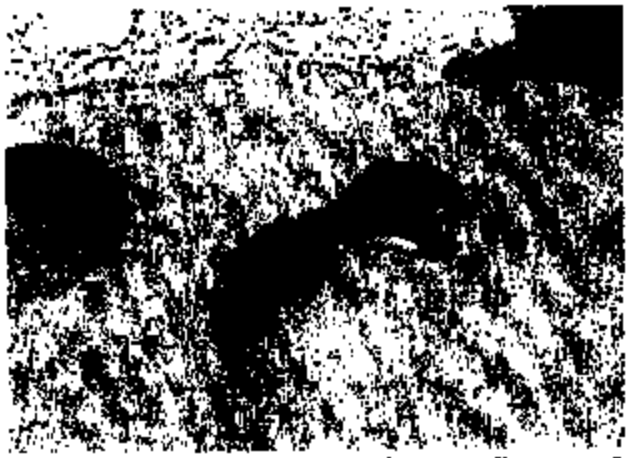


The broken-off U-bolt stub remained in place in the outboard right side rear location (Position # 7) of the front axle. The direction of the final fracture appears to be in the right forward direction of the vehicle, which is consistent with the axle being subjected to a large rearward force while the upper chassis and springs impose a large force on the U-bolt in the forward direction due to their forward momentum.

If any U-bolts had been loose for a period of operation, the U-bolt bores would have wallowed into an oval form from the various acceleration, cornering, and braking loads imposed in the U-bolt suspension joint. The inspected bores appeared to be round with sharp corners indicating that the U-bolts had been tight until a single large force had been imposed on the U-bolt joint.

Corrosion

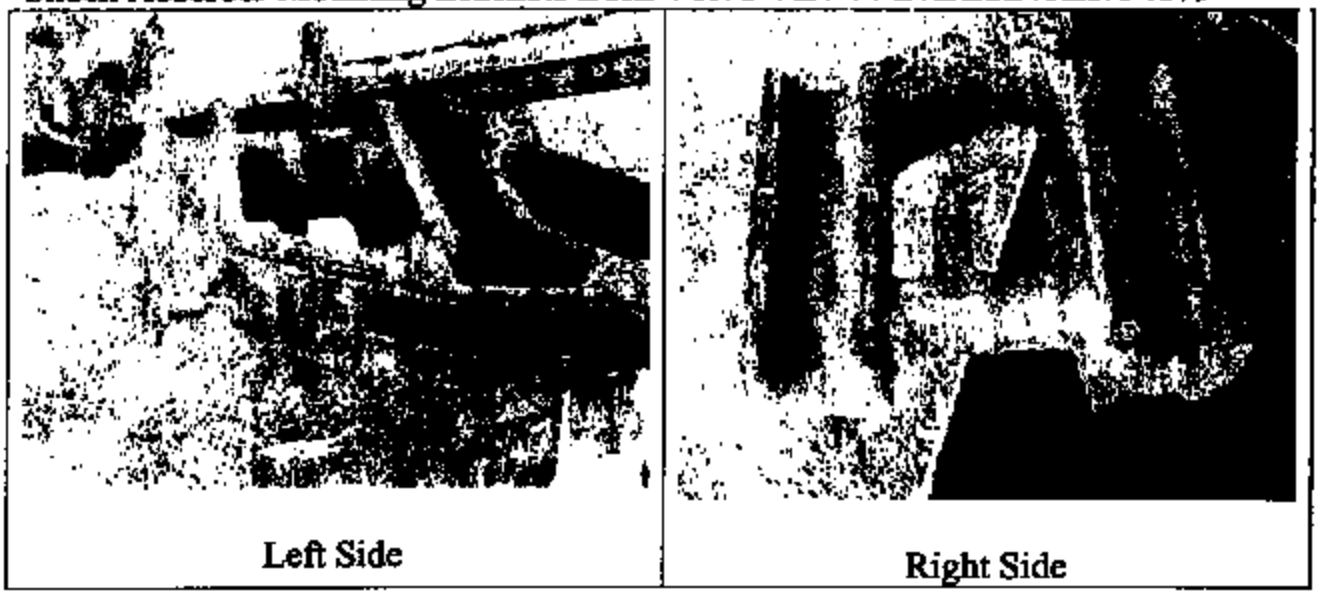
Left Side Mounting Pad, Forward Right Bore Position (# 4)



Right Side Mounting Pad Bore, Forward Right Position (# 6)

Corrosion was evident in the axle mounting bores as well as on the U-bolt threads. The above photographs are representative of the condition of the axle bores. The removed U-bolts have been shipped to VRTC for further analysis; refer to the photographs in the VRTC report for an indication of the corroded condition of the U-bolt threads.

Shock Absorber Mounting Brackets from Volvo VIN 4VG7DBRJ7XH794879

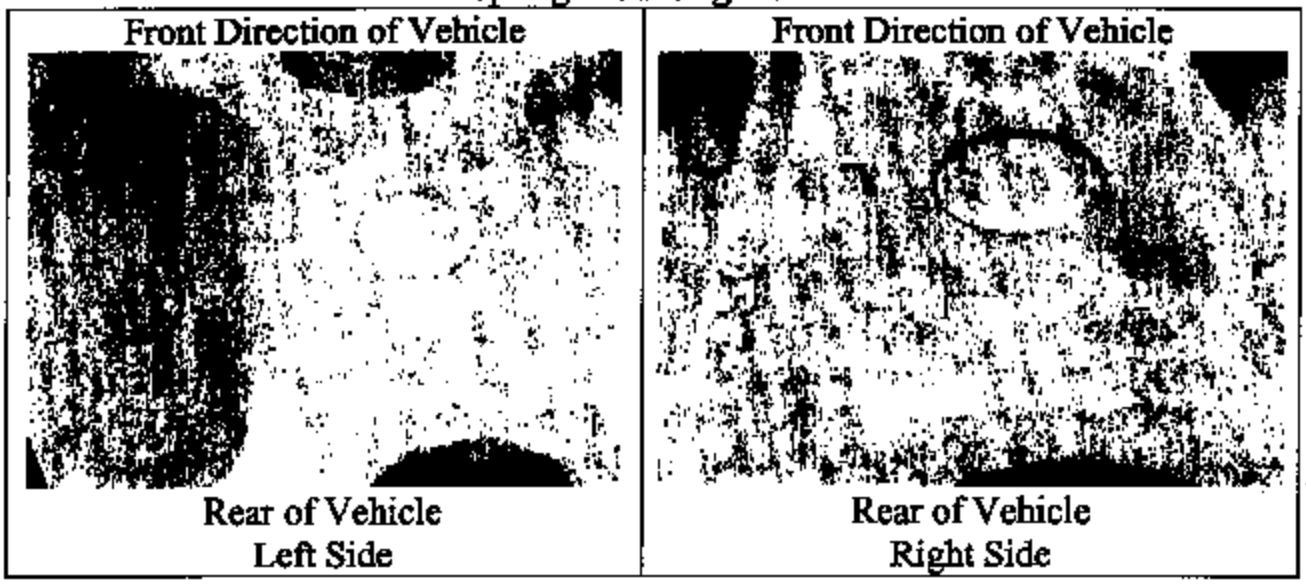


Left Side | Right Side

The above photographs confirm that all eight shoulders of the U-bolt locating grooves on both right side and left side shock absorber brackets (four shoulders on each bracket) exhibit a contact pattern that indicates that U-bolts had at some time been installed at each of the four required U-bolt positions.

Front Suspension Spring Dowel

Spring Mounting Dowel



Rear of Vehicle
Left Side

Rear of Vehicle
Right Side

The photographs show a cresent-shaped deposit on the rearward portion of both right and left side front suspension spring locating dowels. The material appears to have been deposited from the coating or painting on the front suspension springs since it matches the color of the spring coating material. The deposited material is smeared in the forward direction of vehicle travel indicating that the front springs were displaced forward (shearing the dowel and depositing the material) when the front axle was subjected to a large force from the forward direction of the vehicle.

Summary of Findings and Comments

ODI believes that the damage observed in the U-bolts was most likely caused by the following event sequence:

(A) A significant lateral force toward the right side of the vehicle caused the small bend in the middle of the right side leg shank of the U-bolt.

(B) The lateral force was so significant that it exceeded the ultimate strength of the U-bolt which then fractured through the right leg. The right leg and retaining nut must have been in place during this loading to provide a reaction force for this significant tensile force. If the U-bolt leg or retaining nut were not in place, it is doubtful that the U-bolt would have been anchored strongly enough to permit a bend to occur at this mid-point in the U-bolt's right side leg.

The corrosion observed on each of the U-bolts legs reduced the ultimate tensile strength of the U-bolts.

(C) Once the right side U-bolt leg had fractured, the forces continued to bend the U-bolt out of its original position and "opened" (stretched) the right angle bend on the left leg of the U-bolts.

The damage and analysis description is consistent with a frontal collision and vehicle rollover onto its right side.

The mating parts in the U-joint left reasonably clear impressions of the other mating parts indicating that the U-bolt joint had been tight prior to separation. If the U-bolt had been loose, the impression of the mating parts would have a "smeared" appearance caused by relative movement (fretting) of the front suspension springs, the front axle beam, shock absorber bracket, spacers, and U-bolts.

The appearance of unrusted "shiny" metal caused by parts movement might normally provide another indication of a loose joint. However, since the front suspension and U-bolts have been exposed to the elements, ODI has not relied on this indicator.

Conclusions -

ODI believes that the front suspension U-bolts fractured as a result of the vehicle impact and that the front axle U-bolt clamp had not been loose and did not contribute in any way to events preceding the incident. There is no evidence of prior loosening or separation as indicated by the inspected condition of the available components. Available evidence from the front axle bores indicates the U-bolts were subjected to a high load event consistent with a frontal impact.

ODI is concerned that corrosion may have diminished the ultimate strength of the U-bolts.

GTBowman 9/27/02

Excerpts from

PACKER ENGINEERING

INSPECTION REPORT

VTNA VIN 4V4ND1RH5YN791735

May 22, 2002

PACKER ENGINEERING Inc.

PACKER ENGINEERING 40 YEARS

"HOT TRANSPORT" TRUCKING COMPANY METALLURGICAL ENGINEERING EVALUATION OF U-BOLTS

I. INTRODUCTION

A tractor-trailer truck operated by the "Hot Transport" trucking company was involved in a single vehicle accident in Lufkin, Texas. The tractor was a Volvo Model VNL64T, Serial Number 791735, and was pulling a tanker trailer. The vehicle ran off the right side of the road and rolled over onto its right side. After the accident, attention was focused on the four U-bolts which attach the front springs to the front axle of the tractor. It was observed that one side of each of three of the U-bolts had fractured at the end through the threaded portion of the bolt.

Packer Engineering Inc. (PE) was requested to assess the U-bolt fracture surfaces as well as the metallurgical condition of the bolts.

II. MATERIALS REVIEWED

1. Volvo Truck Corporation Drawing 8081654, "U-Bolt, M20" (Appendix A)
2. Volvo Corporate Standard 7121,11, "Fasteners, Mechanical Properties of screws, M threads, Manufacturing specification." (Appendix B)
3. Four subject U-bolts and two threaded sections of U-bolt separated by fracture.

III. RESULTS OF INVESTIGATION

A. Preliminary

Packer Engineering, Inc. (PE) recognizes the possibility of litigation in auto and truck accidents. PE follows the guidelines in ASTM E860-97, "Standard Practice for Examining and Testing Items That Are Or May Become Involved in Litigation." (Appendix C). The premise for this Standard is that if litigation is anticipated, all parties should have the opportunity to examine evidence prior to destructive testing. However, the testing by Packer Engineering on the subject U-bolts was requested by the National Highway Traffic Safety Administration and was the minimum required to determine if the bolts were defective or inadequate in any way.

All of the bolts were examined in detail and the fractures themselves were further cleaned and examined. Hardness tests were performed on all of the bolts. Additional testing was done on the right front U-bolt which required sectioning of the bolt.

B. Overall Assessment of Subject U-bolts

Figure 1 shows the four bolts as received. The bolts were labeled and are also arranged in the photograph according to left and right sides, front and rear, with the front bolts at the top of the photograph. For the left side rear and both right side bolts, one end of the bolt was fractured. Two of the fractured ends are in the plastic bag in the photograph.

All four of the bolts showed an overall and very noticeable bending, consistent with a lateral or shear force between the front axle of the tractor and its attached springs. The bending deformation indicates that the loads on the bolts exceeded the strength of the bolts. Furthermore, the configuration of the deformation was such that the majority of the bending must have preceded the fractures of the ends of the U-bolts. Lateral forces sufficient to deform the U-bolts would not develop during normal operation of the vehicle. In other words, an overall assessment indicated that fracture was the result of the material being overloaded.

C. Localized Deformation at the Fractures

Examination of the bolt ends in the vicinity of the fractures found evidence of local deformation as well. Figure 2 shows the end of the left side rear U-bolt. The orange arrow shows the direction of the bending which resulted in stretching on one side of the bolt and a foreshortening of the threads on the other. Figure 3 shows a similar situation for the right side rear U-bolt. Again, this deformation could not have occurred if the bolts had fractured during normal operation of the vehicle. The deformation on the right front U-bolt indicated relative fore and aft motion between the axle and the spring. The left front bolt showed deformation but no fracture.

D. Optical Inspection of the Fracture Surfaces

As received, the U-bolts were covered with dirt and some rust. To better enable assessment of the fracture features, the fractures were cleaned by immersion in a beaker of acetone with ultrasonic agitation. The fractures after cleaning are shown in Figures 4, 5, and 6 corresponding to left rear, right front, and right rear respectively. The acetone treatment removed most of the dirt and loose rust from the fracture surface. There were a few isolated patches of rust remaining as shown in the Figures. This rust developed after the fracture occurred. All of the fractures appeared to be relatively fresh and of the same vintage. There was no indication of any aging, wearing, or oxidation of any of the fracture surfaces. There was no indication that any portion of the fracture occurred over an extended period of time or prior to any other portion of the fracture.

The fracture surfaces of the right bolts were similar to the cup-cone fracture which is sometimes seen in tensile test specimens. That is, the central portion of the fracture was relatively flat while the outer portions were at an angle (shear lips). This fracture develops due to the different state of stress

which exists at the outside surface of the cross section. The fractures initiated in the roots of the threads due to the stress concentration effect and the deformation was concentrated there. Greater elongation would have been expected if the fractures had initiated on a smooth cylindrical surface.

The left side rear fracture was completely at an angle to the axis of the bolt due to the greater amount of bending associated with that particular bolt end.

Ridges of various depths and orientations were observed on the fracture surfaces. These ridges should not be confused with the beachmarks and striations which indicate fatigue fracture. In fact, the ridges result in a fracture surface which is much rougher than the smooth fracture surfaces typically observed in fatigue.

Again, all aspects of the fracture appearance indicate a fracture which occurred due to the strength of the material being exceeded by the combined bending and tensile forces imposed on the bolts.

E. Fracture Surface Examination in the Scanning Electron Microscope

The fracture of the right front U-bolt was somewhat flatter, showing less shear and bending, than the other two fractures. Also, the nut end of this bolt was not with the other bolt pieces and was therefore not available for assessment. Therefore, the bolt side of the fracture was cut from the rest of the bolt and examined in the scanning electron microscope (SEM) after cleaning. The SEM allows higher magnifications and greater depth of focus than are possible with optical microscopes. Figure 7 shows an area near the edge of the fracture at 1,000X magnification. The fracture occurred through a mechanism known as micro-void coalescence. This fracture appearance is also sometimes described as dimpled rupture or ductile dimples. It results from deformation on a microscopic scale. The orange arrow in Figure 7 shows a particularly clear example of the ductile dimples. Again, ductile dimple fracture results from stresses which exceed the strength of the material.

F. Alloy Chemical Composition

The English language portion of the relevant Volvo Corporate Standard (listed above) was reviewed. Per the drawing, the bolts are to meet the requirements of Property Class 10,9. The Standard specifies metal alloy chemical composition. A section of the right front U-bolt, which was adjacent to the fracture removed for the SEM examination, was analyzed by Metallurgical Services, Inc. of Maywood, IL, an independent laboratory specializing in routine materials testing. Appendix D is their report of May 7, 2002. The sample analyzed meets the Volvo requirements. The sample itself was consumed in this testing.

G. Hardness

The Volvo Standard also includes a hardness requirement for Property Class 10,9. Rockwell C scale hardness is specified to be in the range 32 - 39. Tests were conducted on a cross-section cut adjacent to the fracture of the right front bolt. Readings were obtained at the mid-radius and center of the cross-section. Hardness tests were also conducted on the surfaces of each of the other U-bolts. The laboratory hardness test data are provided in Appendix E. All readings were within the specification. Note that a correction is required when conducting hardness tests on curved surfaces.

H. Microstructure

The Volvo Standard intends at least 90% martensite in the center of the bolt cross sections after quenching to the as-hardened condition. A metallographic cross section was prepared and evaluated. The structure consisted of tempered martensite at the edge and center of the bolt and met the requirements of the Standard.

The Standard describes assessment of decarburization in a thread cross section. Because the fractures were adjacent to threads and the threads indicated the deformation of the bolts prior to fracture, it was desired to maintain these threads intact. The section prepared for metallographic examination was not through the threads. However, decarburization did not appear to be excessive.

IV. SUMMARY, DISCUSSION, AND CONCLUSION

Metals are most useful as engineering materials because they combine high strength with the ability to respond to load by deforming and absorbing energy prior to fracture. The subject U-bolts behaved in this way. They were subjected to forces during the accident which simply exceeded their strength. The bolts all bent and three of the bolts ultimately fractured. There is no indication that the bolts were defective. There is no indication that the performance of the bolts was deficient, no indication of any partial fracture or cracking pre-existing the accident, and no indication that the bolts contributed to the cause of the accident in any way. All testing indicated that they met the requirements of the applicable Volvo Design Standard. It is not unusual or surprising to find deformed and broken parts after an accident of this type.

Further sectioning and testing of the bolts could be performed. However, this was not done, is not recommended, and is not considered necessary given that there was no indication of any problem with the bolts and that others might desire to be present and contribute to further examination and testing. Further testing would further alter the condition of the bolts and consume additional material. For example, tensile testing would consume large fractions of whichever bolts were tested and results might be difficult to interpret given the bending distortion present. The hardness tests do not indicate any deficiency in tensile strength.

V. ADDITIONAL INFORMATION

Dr. Shipley's Curriculum Vitae (C.V.) and additional information on Packer Engineering comprises Appendix F. Dr. Shipley is licensed as a Professional Engineer by examination and has published and made presentations in the area of failure analysis in general and threaded fasteners in particular.

Sincerely,

PACKER ENGINEERING, INC.

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/jkw

ODI INSPECTION REPORT –

VTNA VIN 4V4NC9JH91N318309

April 29-30, 2002

INSPECTION REPORT – VOLVO VIN 4V4NC9JH91N318309
April 29-30, 2002

Introduction -

On April 29 and 30, 2003 Tom Bowman (ODI), Jim Hague (VRTC), and Thad Gardner (TRC) inspected a 2001Volvo Tractor, VIN 4V4NC9JH91N318309 that had been in a single vehicle rollover crash near Mile Marker 93 on eastbound I-10 (near Deming, NM) on October 16, 2002.

Prior to the inspection visit, witnesses had informed NHTSA that the tractor-trailer combination had made an abrupt departure from the roadway toward the left (into the median of the divided four-lane highway) causing the vehicle to roll to the right (or passenger side) direction. The driver and passenger were killed in this single vehicle crash.

The post crash police report, tow truck operator and an owner operator (who reported the incident to NHTSA) had each performed cursory examinations of the vehicle and observed that the front suspension U-bolts in the post-crash vehicle had fractured. Based on this information, ODI believed that a more detailed inspection was justified.

Purpose -

The general purpose of this inspection was to provide information to assist ODI's investigation of "20 MM Coarse Thread Front Suspension U-bolts installed in Volvo tractors manufactured between 1998 and 2001" (EA02-021).

The specific purpose of this inspection was to determine (1) whether the inspected components indicated that any malfunction of the front suspension retention system (U-bolts) had occurred and, if so, (2) whether the malfunction had caused or contributed to the October 16, 2002 crash.

Summary of Findings -

The evidence obtained from the police report, the post-crash (E & A) photographs, and the inspections of the post-crash components indicates that the front axle suspension U-bolts had fractured as a result of the loads imposed by the crash. The evidence did not indicate that the U-bolts had been factors in causing or contributing to the crash.

Methodology -

The investigation consisted of the following:

(1) ODI conducted phone interviews with the police officer who reported the crash and the tow truck operator who removed the wrecked vehicle from the crash site;

(2) ODI reviewed the police report and post-crash photographs taken by Evans & Associates (E & A);

(3) ODI, VRTC, and TRC personnel conducted a field inspection of the front suspension U-bolts, front axle assembly, and tractor which were being stored at various locations in New Mexico.

This field inspection focused on (A) the "missing" U-bolt; (B) the fracture, deformation and evidence of clamp provided by the three remaining U-bolts and mating parts; and (C) the evidence provided by various peripheral parts of the vehicle.

Inspection Schedule -

The ODI-VRTC inspections were conducted over a two day period at three locations:

Date Of Inspection	Location	Components Inspected
April 29, 2003	Evans and Associates (E & A) 1681 Hickory Loop Las Cruces New Mexico	(1) Three fractured and bent front suspension U-bolts with attaching hardware. A fourth U-bolt had been reported "missing" at the crash site and it has not been recovered.
April 29, 2003	M & D Towing, 125 Arizona Road S.W. Deming New Mexico	(2) Front axle assembly identified as "FF-986-LX2, 8082906, s/n AVF00188869 (3) a single fractured upper leaf from the passenger side of the front suspension (4) Dorsey refrigerated trailer (stripped)
April 30, 2003	Ryder Truck Maintenance Facility 1500 Mission Avenue NE Albuquerque New Mexico	(5) Volvo Tractor VIN 4V4NC9JH91N318309

The inspection team also drove past mile-marker 93 of Interstate 10 while traveling from Las Cruces to Deming and performed a cursory inspection of the crash site.

Background -

On February 14, 2003,an independent Volvo tractor owner-operator, sent an e-mail to ODI reporting that he had observed a wrecked Volvo tractor at M & D Towing in Deming, New Mexico (later moved to Albuquerque) and that the front suspension U-bolts appeared to have fractured leaving the front axle separated from the tractor. The owner-operator suggested that ODI should examine the U-bolts in this vehicle inasmuch as it appeared to him that the U-bolt breakage could have been the cause of the crash.

ODI contacted several individuals by phone prior to conducting the April 29 and 30, 2003 inspection for the purpose of developing a clearer understanding of the crash circumstances and the whereabouts of the post-crash components.

ODI interviewed the following individuals:

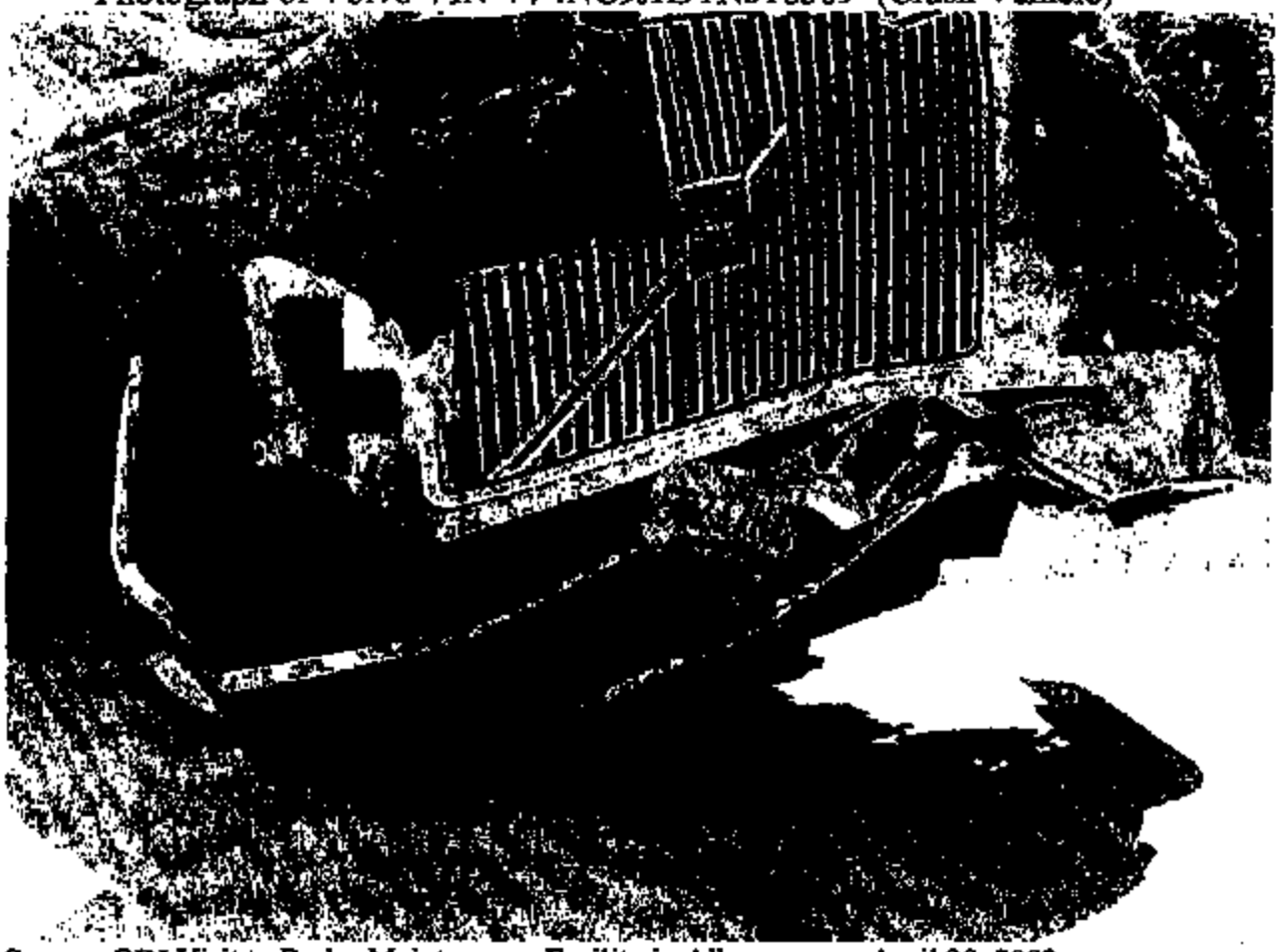
(1) The New Mexico State Police officer who had been sent to the crash site immediately after the crash and prepared New Mexico State Police Report (# 4701898) regarding the incident. At ODI's request, the New Mexico State Police furnished ODI with a copy of this accident report (attached).

(2) An engineer associated with Evans & Associates (E & A) who had been retained by Ryder Trucks to take photographs of the crash site and the post-crash vehicle and related components. At ODI's request, E & A provided copies of 158 photographs to ODI. These photographs were accompanied by a short written summary dated December 17, 2002 that indicates that the photographs had been taken on October 31, 2002, approximately 15 days after the October 16, 2002 crash.

ODI has referred to the E & A photographs since these photographs were taken 15 days after the crash and provide a record of time-sensitive evidence such as tire tracks and the positioning and condition of crash-related evidence that could easily have been compromised by subsequent handling, relocation to various storage locations, exposure to the elements, etc.

(3) ODI interviewed the tow truck operator. The E & A post-crash photographs (numbered 85, 93, 94, 95) showed that the ball stud was separated from the drag link and ODI was concerned about whether this separation might have preceded the crash and therefore been a possible factor in causing the crash. Through the phone interview, ODI learned that the tow truck operator had found the drag link ball stud connected to the steering arm in the post-crash wreckage and had removed the ball stud from the steering arm to facilitate removal of the vehicle from the crash site.

Photograph of Volvo VIN 4V4NC9JH91N318309 (Crash Vehicle)



Source: ODI Visit to Ryder Maintenance Facility in Albuquerque, April 30, 2003

At some time after the crash, the tractor had been transferred from M & D Towing in Deming to the Ryder Maintenance facility in Albuquerque, New Mexico.

The front axle was separated from the chassis but the front axle serial number information on the tractor's VIN tag corresponds to the front axle assembly that was inspected in Deming on April 29, 2003.

The appearance of the vehicle is consistent with the photographs taken by E & A shortly after the crash and the damage is consistent with what would be expected when a vehicle has experienced a roll in passenger side direction.

Crash Site

There were no evident marks on the highway surface that could be associated with the October 16, 2002 crash. The road surface appeared to have been recently resurfaced along this portion of the highway and any gouge, scrape or tire marks that may have been evident after the crash and/or on the post-crash photographs taken by E & A were not evident at the time of the April 29, 2003 inspection.

Police Accident Report Summary -

New Mexico State Police Report # 4701898 describes a single-vehicle dual-fatality crash in which a 2001 Volvo tractor identified as VIN 4V4NC9JH91N318309 hauling a 1999 Dorsey trailer loaded with fresh produce had been traveling eastbound on I-10, a divided four-lane highway. The crash occurred near mile marker 93 at approximately 6:40 PM on October 16, 2002. The roadway conditions were reported to be dry, clear, straight, and level. The crash occurred at "dusk."

The police report indicates that the deceased were taken to Baca's Funeral Home. The report does not indicate that an autopsy had been performed and states that the sobriety of the driver was unknown.

The police report narrative describes the witness' account as follows,

> "(the witnesses) ... had been eastbound in the left lane [1] traveling at 65 MPH when the tractor-trailer passed them in the left lane [1]. The tractor-trailer the (sic) then changed lanes into the left lane [1] in front of them. The tractor-trailer then suddenly went in to (sic) the median and overturned...there was no traffic in front of the tractor-trailer before it went into the median..."

[1] ODI notes that statements (a) the witness vehicle was traveling in the left lane and (b) that the tractor-trailer had "passed them in the left lane" are possibly contradictory. New Mexico Accident Report # 4701898 provides a diagram that depicts the crash site and records various scrape and tire marks left in the roadway surface after the crash. This diagram in the report shows that the tire marks originate in the far right lane and the accompanying description states that the tractor-trailer had been "in the right lane when it suddenly went across the left lane."

ODI cannot determine with certainty whether the tractor-trailer passed the witness vehicle on the right or the left side. The police report and photographic evidence of the crash site evidence indicate that the tractor-trailer lost control from the right lane.

Discussion of Observations in New Mexico Police Accident Report regarding Front Suspension U-Bolts

New Mexico Police Report # 4701898 states that

> "the driver side out side (sic) bolt was broken on one end; the inside bolt was missing. The outside bolt was broken at the front-end one end (sic) and the break was at an angle through the threaded portion."

The above comment indicates that the police officer that inspected the post crash components believed that the front suspension U-bolts had been installed in a front to rear orientation (as indicated by describing "inside" and "outside" U-bolts) whereas the U-bolts are actually installed laterally (side to side) across the front axle mounting pad.

Description of U-Bolts and Reference Sketch

Four U-bolts are used to secure the front axle suspension components to the front axle in the vehicle. One U-bolt is installed laterally in the forward position and a second U-bolt is installed laterally in the rearward position through paired sets of holes that are bored into the both the right and left suspension mounting pads of the front axle I-beam.

ODI has numbered the U-bolt mounting holes for reference purposes. The numbering convention used to identify the various mounting "Positions" are summarized in the sketch and table below. Four U-bolts are installed to retain the front suspension to the axle: one U-bolts through positions 1- 2, one U-bolt through positions 3 - 4, etc.

Position #	Description	Position #	Description
1	Drivers Side Rearward Inboard	5	Passenger Side Forward Inboard
2	Drivers Side Rearward Outboard	6	Passenger Side Forward Outboard
3	Drivers Side Forward Outboard	7	Passenger Side Rearward Outboard
4	Drivers Side Forward Inboard	8	Passenger Side Rearward Inboard

Identifying the Location of Missing U-bolt

ODI identified the position of the "missing" U-bolt by first identifying the pre-crash positions of the three surviving U-bolts. Based on the labeling affixed to the U-bolts, the presence of either a flat washer (indicating forward position) or a tapered plate (indicating a rearward position), and a review of photographs identified by numbers 85, 86, 88, 90, 93, 95, 96 in the E & A report dated December 17, 2002, ODI believes that the "missing" U-bolt had been installed transversely in the drivers side forward position identified as "Position 3-4."

Discussion -

The suspension design requires flat washers to be installed between the lower face of the axle suspension mounting pad and the U-bolt nuts in the forward suspension positions identified as Positions 3, 4, 5 and 6 and that tapered plates be installed between the lower face of the axle suspension mounting pad and the U-bolt nuts in the rearward positions identified as Installation Positions 1-2 and 7-8. (See Appendix B for reference.)

Photographs 85, 90, 93, 95 and 96 provided by E & A show a portion of a bent and fractured U-bolt resting in the rearward position of the driver side rearward front axle suspension mounting bore (Position 2). This U-bolt has been bent and had been displaced (or dislodged) from its originally installed position in the front axle. The fractured end of the U-bolt is hanging in the driver side rearward bore (Position 2) of the front axle mounting pad and the other non-fractured end of this U-bolt is supported by the attached tapered plate which is draped over the front axle cross-tube assembly. The positioning of the U-bolt and the presence of the tapered plate indicate that this U-bolt had been installed laterally across the driver side rear position (Position 1 - 2).

This U-bolt corresponds to the U-bolt that the New Mexico Accident Report # 4701898 describes as the "remaining (driver side) U-bolt."

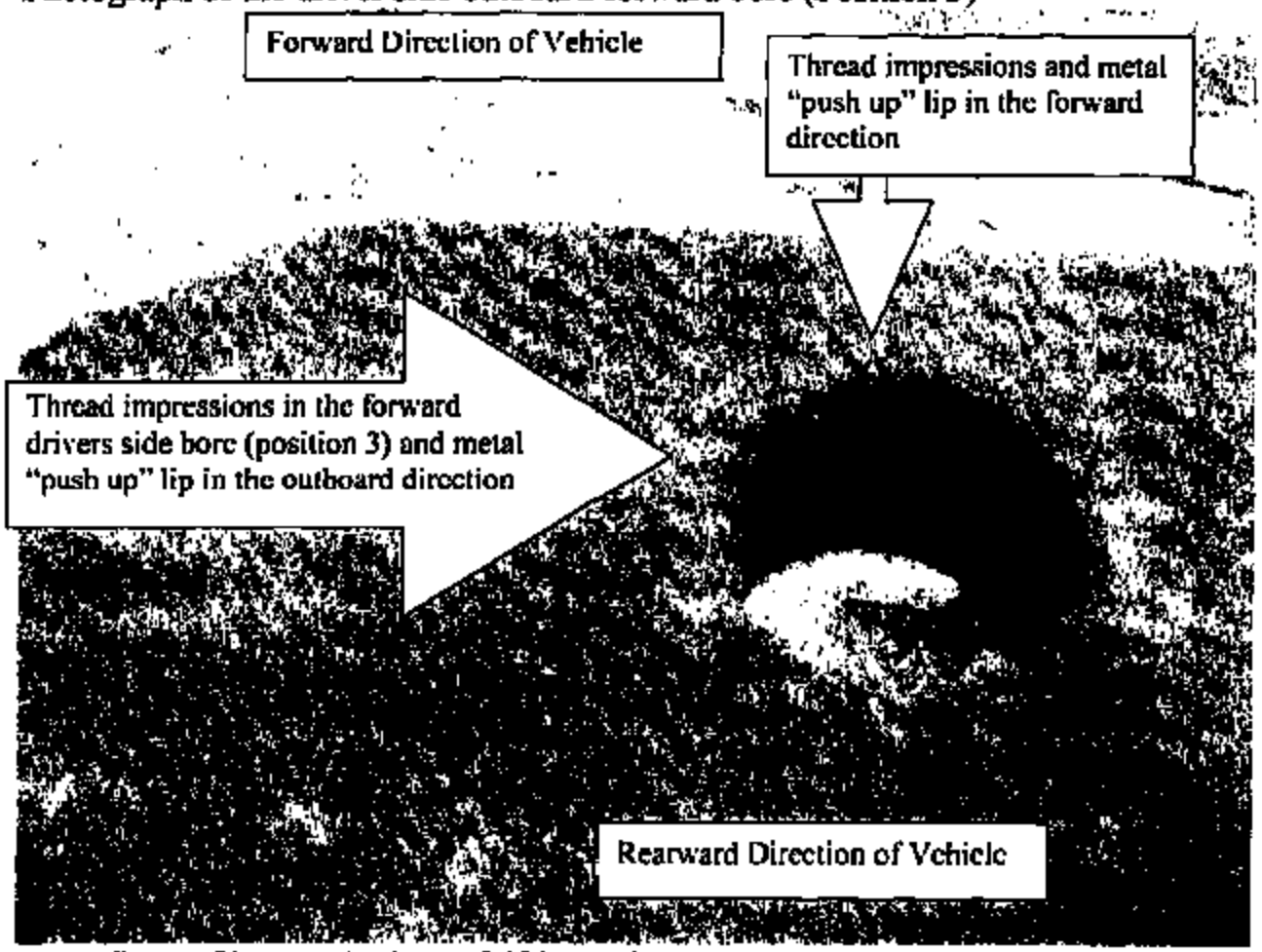
(1) Flat Washer Witness Marks-

The flat washers installed in the drivers side forward ("missing" U-bolt) position (Position 3-4) had left clear witness mark impressions on the bottom face of the front axle mounting pad. These impressions were consistent in appearance with the impressions left on the underside of the other suspension mounting pads indicating that the "missing" U-bolt had been in position for essentially the same period of time as the other U-bolts attached to this axle. The washer impressions in the axle were distinct indicating these parts had been tightly clamped since there are been no evident movement of the washer relative to the axle.

(2) Thread impressions in the Driver Side Forward Axle Bore at Position 3

The "missing U-bolt" had been installed through the driver side outboard forward bore (Position 3). Thread impressions in the outboard and forward topmost faces of the bore in the front axle are distinct indicating that single load had been applied with sufficient force to indent the bore surface in (1) the outboard and (2) the forward directions. (See photograph below)

Photograph of the driver side outboard forward bore (Position 3)



Source: Photograph taken at ODI inspection at D & M Towing, April 29, 2003.

The opposite end of the "missing U-bolt) had been installed in inboard forward drivers side front axle bore (Position 4). Position 4 bore did not exhibit any witness marks in the bore indicating that the drivers side forward leg of the U-

bolt had not been subjected to the same loads as the drivers side front axle bore (Position 4).

ODI speculates that the forward driver side ("missing") U-bolt had fractured in a manner similar to that observed in the three remaining U-bolts. (See comparison photographs in the following section.)

ODI further speculates that the fractured permitting the short straight section of the U-bolt at Position 4) dropped through the axle bore and away from the vehicle. After the fracture of the driver side forward inboard U-bolt had occurred, the remaining portion of U-bolt had been bent upward in a manner similar to that observed in the other three U-bolts that had been installed in this vehicle. Upward force applications imposed on the inboard leg of the U-bolt pressed the threads of the outboard leg into the axle bore in the (1) outboard and (2) forward directions.

(3) Evidence of Clamp -

The round flat washers installed in the forward U-bolt installation positions (3, 4, 5, and 6) and the rectangular plate installed in the rearward U-bolt installation positions (1 - 2 and 7 - 8) made distinct impressions in the bottom face of the front axle suspension mounting pads. The distinct appearance of the impressions indicates that had been clamped in position firmly and had not shifted, fretted, or moved relative to the axle mounting face up to their ultimate separation from the axle face. (Also refer to Photograph 102 taken by Evans and Associates.)

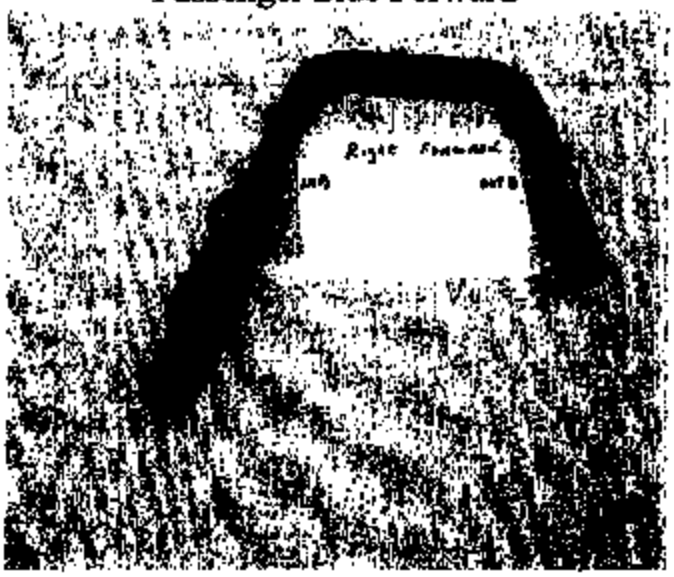
The following photographs show the front suspension U-bolts arranged according to their position as originally installed in the subject vehicle.

Drivers Side Forward

Missing U-bolt

Position # 3 Position # 4

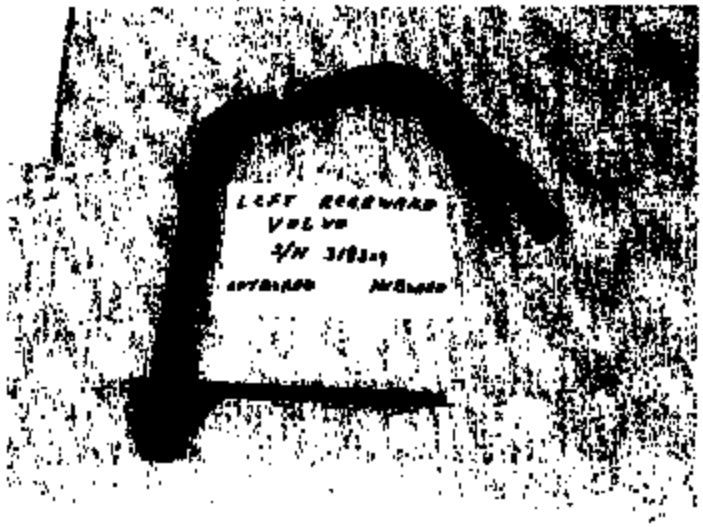
Passenger Side Forward



Position # 5 Position # 6

The installed flat washer indicates that this U-bolt (imprinted with part number "M00307") had been installed in a forward position.

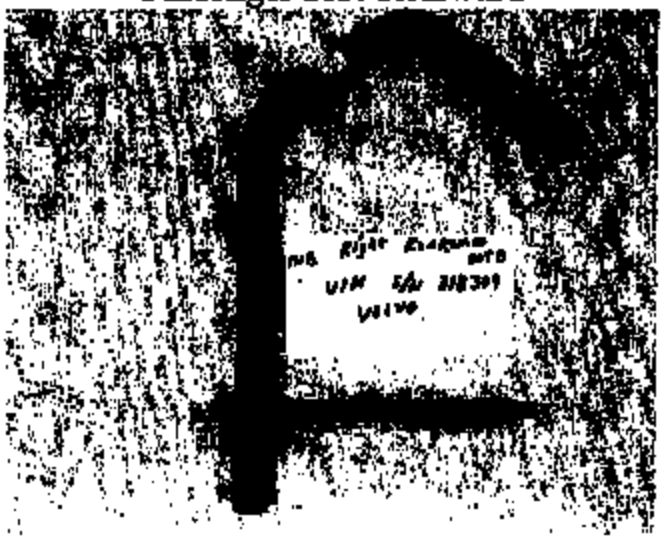
Drivers Side Rearward



Position # 2 Position # 1

The installed tapered plate indicates that this U-bolt (imprinted with part number "8081551") had been installed in a rearward position.

Passenger Side Rearward



Position # 8 Position # 7

The installed tapered plate indicates that this U-bolt (imprinted with part number "8081551") had been installed in a rearward position.

Source: ODI photographs taken at Evans & Associates - April 28, 2003

The three surviving U-bolts had been bent outward in the direction of the passenger side of the vehicle indicating that the U-bolts had been subjected to a significant load in the direction of the vehicle's passenger side.

The fracture faces of the three U-bolts exhibited modest corrosion that has obscured some of the features of the fracture face. There was no visible evidence that fatigue cracks had developed in any of the U-bolts prior to fracturing.

Discrepancy in U-Bolt Part Marking -

ODI noted that passenger side forward U-bolt was imprinted "3M00307." Since ODI had not previously been aware of "3M00307" as part number relevant to this investigation, ODI requested Volvo Trucks North America (VTNA) to identify the part numbers of the front suspension U-bolts that had been originally installed in VIN 4V4NC9JH91N318309. VTNA responded that all four of the originally installed front suspension U-bolts were part number "8081551."

ODI requested Ryder Truck to provide vehicle maintenance records pertaining to the front suspension. These records indicated that maintenance described as "repair U-bolts front spring" had been performed on September 21, 2002. Although the service record does not indicate that any U-bolts were replaced, it is likely that U-bolt "3M00307" had been installed as a replacement for the originally installed U-bolt at that time.

Since there were no indications that the U-bolts had lost their clamp until subjected to the catastrophically high loads associated with the crash forces, ODI did not elect to perform a metallurgical examination on any of the U-bolts examined during this field inspection

Passenger Side U-bolts -

The two passenger-side U-bolts appeared to be fractured and deformed in a similar pattern. Both U-bolts had fractured through the threaded section of the outboard leg proximate to the section transition between the shank and threads. The fracture face is essentially flat across the face of the U-bolt and exhibits a "coarse" appearance indicating that the fracture was caused the application of a single force sufficiently large to fracture the U-bolt. There was no evidence such as a fatigue crack propagation zone that would have indicated that the U-bolts had been cracked prior to the ultimate fracture.

Both of the passenger side U-bolts exhibited indentations on the inboard faces of both the inboard and outboard legs of the forward and rearward U-bolts at two locations along the inside face. The indentations are approximately opposite the edges of the two front suspension springs and were most likely caused by the edges of the springs pressing into the leg of the U-bolt. The indentations on each leg are slightly offset from each other indicating that the springs had contacted the U-bolt from somewhat different directions implying that the springs had splayed relative to each other at the time that they contacted the U-bolt.

The legs on the fractured portion of the U-bolts have essentially retained their "straight" appearance but exhibit a minor outward bend in the U-bolt leg at a location on the opposite side of the of the indentations. The location of the bends in the legs of the U-bolts are in the direction of the passenger side of the vehicle and correspond to the location of the indentations on the opposite and inside leg of the U-bolts. (Also refer to photographs 104, 105,106, 116, 117,118, 119, 120, and 121 for additional views of the inboard U-bolt leg "indentations.") The location of the outward bend indicates that the forces that made the indentations also bent the U-bolts at these points.

In normally aligned and tightened suspension installations, the spring leaves do not contact the U-bolts. The evidence of the indentation or contact on the inside face of the outboard U-bolt legs indicates that the leaf springs had been displaced forcefully outboard from their normal position and, at least initially, the U-bolt was held in place with a clamp sufficient to resist the indentation and bending forces exerted by the displaced leaf springs.

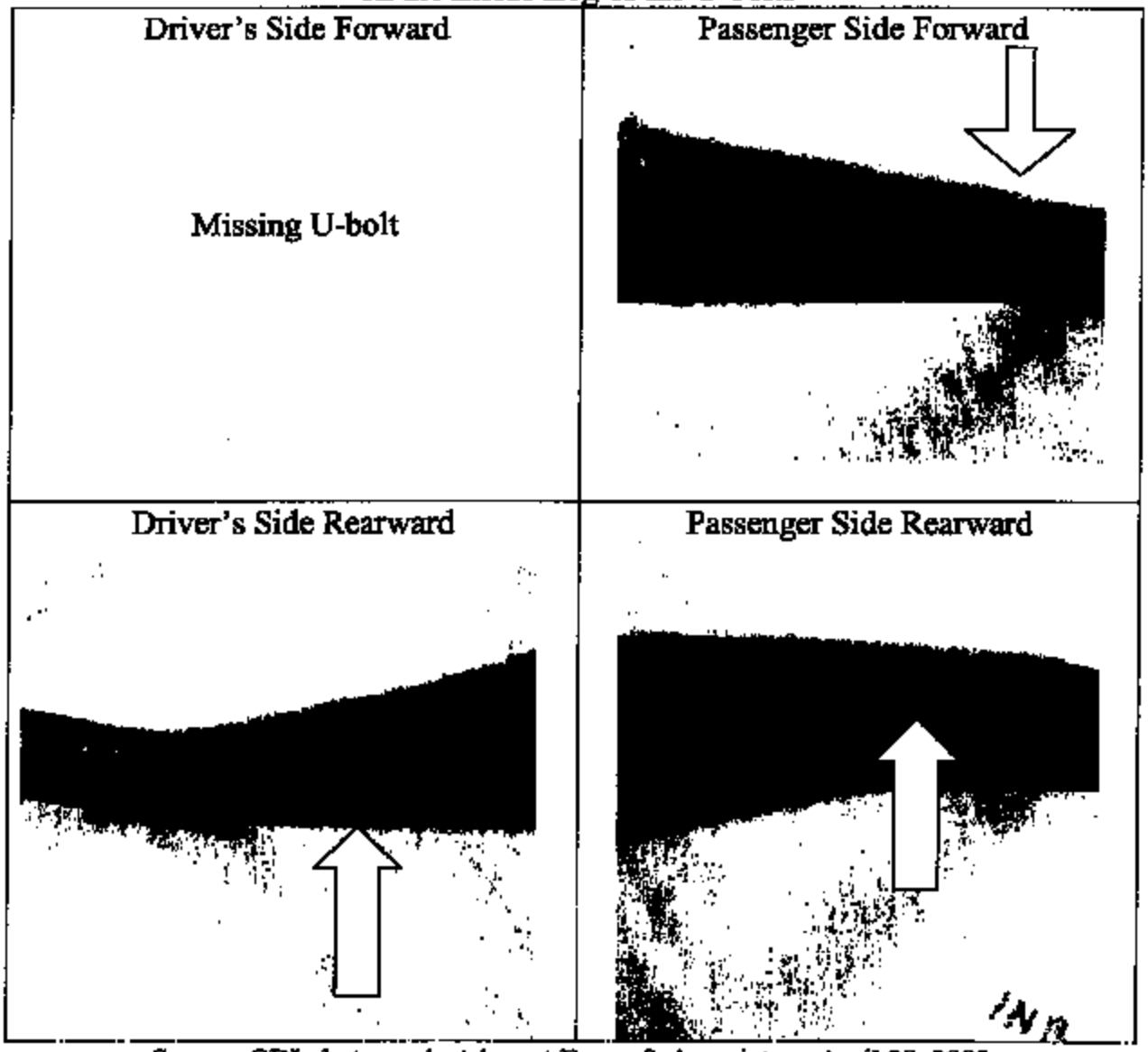
Drivers Side U-bolt -

One driver side U-bolt was found after the crash. Earlier analysis outlined in this report has identified this U-bolt as having been installed in the driver side rear position (Position 1-2). The fractured leg on this remaining (rearward) driver side U-bolt showed a more significant bend in the inboard fractured leg of the driver side U-bolt than observed on the passenger side U-bolts. An indentation was evident on the inside of the U-bolt leg at the location opposite the bend indicating that the force had been imposed from the edge of the spring.

The driver's side U-bolt fracture face is "coarse" in appearance indicating that the U-bolt had experienced a single large force sufficient to fracture the U-bolt. There was no evidence such as a fatigue crack propagation zone or other indications that would have indicated that the U-bolts had been cracked prior to the ultimate fracture.

The fracture surface extends approximately 45 degrees across the fracture face rather than the nearly "straight" fracture observed on the passenger side U-bolt. The appearance of the driver's side U-bolt fracture face differs from the appearance of the passenger side U-bolt fracture faces indicating that the forces applied to the driver's side U-bolt differed from those applied to the passenger side U-bolts.

Appearance of "Indentations" or Deformation
on the Inside Leg of the U-bolts



Source: ODI photographs taken at Evans & Associates - April 28, 2003

Appearance of U-bolt Fracture Faces

Driver's Side Forward	Passenger Side Forward
Missing U-bolt	
Driver's Side Rearward	Passenger Side Rearward
	

Source: ODI photographs taken at Evans & Associates - April 28, 2003

Axle Bores -

If a U-bolt were to loosen, the U-bolts could shift and fret against upper and lower edges of the front axle suspension mounting bores as the suspension system shifts (or displaces) in response to various road load events. With the exception of the driver side outboard forward bore (Position 3) discussed earlier, the bores appeared to be round with square edges indicating that none of the U-bolts had been loose prior to their catastrophic deformation when subjected to high crash-related forces.

Other Vehicle Systems Examined –

Cursory inspections of the (A) steering system, (B) front suspension system, and (C) tires of the subject vehicle did not indicate any apparent defects in these systems.

(A) Steering System Linkages and Steering Gear -

The front axle steering arm, knuckles, cross-tube, cross-tube arms, and tie rod ends appeared to be intact. The "axle end" of the drag link had been intentionally separated from the steering arm to facilitate vehicle removal from the crash site as stated earlier in this report. The "steering gear" end of the drag link remained attached to the Pitman arm. The drag link had been bent upward and exhibited evidence of contact with another object in the area where it was bent. The steering linkages appeared to have been intact prior to the crash. The bend in the drag link was most likely caused by the vehicle crash.

The steering wheel was rotated without engine power assistance: the Pitman arm traveled smoothly through its range of motion.

(B) Front Suspension System -

The fore and aft ends of the driver and passenger side lower leaf springs and the fore and aft passenger side upper leaf were inspected and found to be intact. These intact connections indicate that the front axle position relative to the vehicle frame had been maintained. .

The passenger side lower leaf had separated and was missing from the tractor. This "missing" lower leaf corresponds to the separated and fractured leaf spring inspected at the M & D salvage yard. The passenger side spring fracture appeared to have fractured as a result of a significant force imposed on the springs by the crash.

(C) Tires-

Both front tires were mounted to the front axle assembly. The driver side tire appeared to be inflated; the passenger side tire had de-beaded from the rim. There was no evidence of puncture, flat spots, or unusual wear on either of the front tires.

Position	Tire Size	DOT Information
Drivers Side Front	Bridgestone 295/75 R22.5	2 CBT5CT13C2
Passenger Side Front	Bridgestone 295/75 R22.5	2 CBT5CT1902

The passenger side tire de-beading may have occurred when the tire was subjected to high lateral forces associated with the vehicle rolling in the passenger side direction.

Six of eight rear tires were mounted to the rear axle assembly. The two outermost drivers side tires had been removed from the vehicle. The remaining six tires appeared to be inflated and did not exhibit any evidence of puncture, flat spots, or unusual wear.

Conclusions -

All four of the front suspension mounting bolts installed in the front suspension of Volvo VIN 4V4NC9JH91N318309 had been installed and clamped up to the time of the crash event. The front suspension components did not exhibit any indications that the front suspension clamp had loosened prior to the crash.

The appearance of the fracture faces of the U-bolts and witness marks on various component surfaces (outward bend of U-bolts, impressions on inside legs of the U-bolts, and impressions of threads into the front axle bore) indicate that the vehicle experienced a significant force(s) which forced the front suspension

components outward from the front axle primarily in the passenger side direction.

Based on these inspections, ODI did not find any evidence that indicated that the front axle suspension and U-bolt integrity were factors that caused or contributed to the vehicle crash event.

GTB

Appendix A – Police Report

NEW MEXICO STATE POLICE

REPORTING DEPARTMENT

☐ ON PRIVATE PROPERTY ☒ FATAL ☐ INJURY ☐ PROPERTY DAMAGE ONLY ☐ UNDER $500 ☐ $500 OR MORE ☐ HIT AND RUN

47018 98

STATE OF NEW MEXICO UNIFORM ACCIDENT REPORT

DATE OF ACCIDENT	Military Time	CITY OCCURRED IN	COUNTY	STREET
mo. 10 day 16 yr 02	18:40	N/A	LUNA	1 OF 2 STREETS

SUN ☐ M ☐ T ☐ W ☒ T ☐ F ☐ SAT ☐ OCCURRED ON: (STREET, RD, OR HWY#) INTERSTATE 10 AT INTERSECTION WITH: N/A

OTHER LOCATION 8 ☒ FEET ☐ MILES N S ☒ W OF PERMANENT LANDMARK, COUNTY LINE - INTERSECTION OVERPASS AT MILE MARKER 85

FOR USE BY ORIGINATOR DISTRICT CASE NUMBER

MILEPOST LOCATION 2 ☐ FEET ☒ MILES N S E ☒ OF MILEPOST NO. 93

ACCIDENT OCCURRED ☐ On Roadway ☒ Off Roadway

ACCIDENT CLASSIFICATION ☒ Overturned ☐ Other Non-Col. ☐ Pedestrian ☐ Other Vehicle ☐ Vehicle On Other Roadway ☐ Parked Veh. ☐ R.R. Train ☐ Pedalcyclist ☐ Animal ☐ Fixed Object ☐ Other Object

VEHICLE NO. 1

HEADED N S ☒ W on: INTERSTATE 10

Posted Speed	Safe Speed
75 MPH	75 MPH

Driver's Full Name	Address	Zip Code	Phone
STROUT, JASON L.	7109 N. Providence Rd. Clarmont, IL.	62421	(618) 869-2650

Driver License Number	State	Type	Restrictions	Expires	Date of Birth
S350-4327-7238	IL	A	NONE	08-21-2005	Mo. 08 /Day 21 /Yr 77

Seat Position Code (LD LF / CR CE / RR RF)	7.	Social Security Num.	Occupation
	OTHER		TRUCK DRIVER

Seat Pos.	Occupant's Name	Occupant's Address / Zip Code	Seat Belt	Helmet Yes No	Age	Sex	Injury
Sleeper	KNIGHT, ROBERT T.	1270 Little Marrowbone Road Ashland City, TN. 37015	7	NO	25	M	K1
			7	NO	44	M	K1

Vehicle Yr	Vehicle Make	Color	Body Style	Removed To:	Removed By:
2001	VOLVO	WHITE	D3	DEMING, NM.	M & D TOWING

License Yr.	State	License Number	US DOT/ICC/SCC Number	VIN	Owner's Telephone
01-2003	TN.	58237HY	DOT#00728634	4V4NC9JH91N318309	(615) 585-1998

Owner Name	Owner's Address	Zip Code
Ryder Truck Rental (Lessee, Commodore Express Inc.)	P. O. BOX 507 ANTIOCH, TN.	37011

Insured By: (Name of Company)	Policy Number	Liability Insurance	VEHICLE DAMAGE
Federal Insurance Company (816) 969-9000	7326576	☒ Yes ☐ No	☒ REAR ☐ RIGHT ☐ MIDFRONT ☐ MIDREAR

VEHICLE NO. 2 / PEDESTRIAN / OTHER

HEADED N S E W on: N/A

Posted Speed	Safe Speed

Driver's Full Name	Address	Zip Code	Phone
N/A			

Driver License Number	State	Type	Restrictions	Expires	Date of Birth Mo. /Day /Yr

Seat Position Code (LD LF / CR CE / RR RF)	7.	Social Security Num.	Occupation
	OTHER		

Seat Pos.	Occupant's Name	Occupant's Address / Zip Code	Seat Belt	Helmet Yes No	Age	Sex	Injury

Vehicle Yr	Vehicle Make	Color	Body Style	Removed To:	Removed By:
N/A					

License Yr.	State	License Number	US DOT/ICC/SCC Number	VIN	Owner's Telephone

Owner's Name	Owner's Address	Zip Code

Insured By: (Name of Company)	Policy Number	Liability Insurance	VEHICLE DAMAGE
		☐ Yes ☐ No	☐ REAR ☐ RIGHT ☐ MIDFRONT ☐ MIDREAR

INJURED First Aid Rendered By	Injured Taken To	By
Deming City Ambulance	Baca's Funeral Chapel	Medical Examiner

DESCRIPTION OF PROPERTY AND DAMAGE — Owner Phone

OTHER PROPERTY INVOLVED: NONE

Owner's Name — Owner's Address/Zip Code

WITNESS	Name	Age	Address	Telephone
	Natasa Ona Welch		8450 Glenoaks Sun Valley CA 91352	818 314-6903
	Veronica Caderone		6904 SE Campbell Milwaukee OR	503 772-0310

INJURY CODES: B- Killed (H1 Head, H2 Neck, H3 Chest, H4 Other); A- Incapacitated (Carried From Scene: A1 Head, A2 Neck, A3 Chest, A4 Arm/Leg, A5 Back; B- Visible Injury: B1 Head, B2 Neck, B3 Back; C- Complaint of No Visible Injury; O- No Apparent Injury)

RESTRAINT CODES: 1. Restraint-Not Specified; 2. Restraint-Not Used; 3. Lap Belt-Used; 4. Shoulder Harness-Not Used; 5. Shoulder Harness-Used; 6. Belt And Harness-Used; 7. Ejected From Vehicle; 8. Child Restraint Device: A. Used Properly, B. Not Used, C. Used Improperly; 9. Airbag Deployed: A. Other Restraint Used, B. Other Restraint Used

10/23

ROAD/WEATHER

LIGHTING (Check One)	WEATHER (Check One)	ROAD COND. (Check One For Each)	ROAD SURFACE (Check One For Each)	TRAFFIC CONTROL (Check One For Each)	ROAD CHARACTER (Check One)	ROAD DESIGN (Check One or More For Each)
☐ Daylight	☒ Clear	☒ Dry	☐ Paved Unstriped	☐ No Passing Zone	☒ Straight	☐ 1 Lane
☐ Dawn	☐ Raining	☐ Wet	☐ Paved Center Stripe	☐ Stop Sign	☐ Curve	☒ 2 Lanes
☒ Dusk	☐ Snowing	☐ Snow	☒ Paved Center & Edgelines	☐ Traffic Signals	GRADE (Check One)	☐ 3 Lanes
☐ Dark - Lighted	☐ Fog	☐ Ice	☐ Unpaved	☐ Yield Sign	☒ Level	☐ 4 Lanes
☐ Dark - Not Lighted	☐ Dust	☐ Loose Material		☐ R.R. Gate	☐ Hillcrest	☐ Undivided
☐ Other	☐ Wind	☐ Other		☐ 4 Way Stop	☐ On Grade	☒ Physl. Div
	☐ Other			☐ Flashers	☐ Dip	☐ Paint Div
				☐ No Controls		
				☒ Other		

EVENT

APPARENT CONTRIBUTING FACTORS (Check One or More For Each)			WHAT DRIVERS WERE DOING (Check One for Each)	
☐ Excessive speed	☐ Following too closely	☐ Defective tire	☒ Going straight	☐ Stopped for traffic
☐ Speed too fast for condition	☐ Made improper turn	☐ Other mechanical defective	☐ Overtaking-passing	☐ Stopped for sign/signal
☐ Failed too yield right of way	☐ Driver inattention	☐ Road defect	☐ Right turn	☐ Stop in traffic lane
☐ Passed stop sign	☐ Under influence of alcohol	☒ Other- No driver error	☐ Left turn	☐ Start from park
☐ Disregarded traffic signal	☐ Other improper driving	☐ Traffic control not functioning	☐ U-turn	☐ Parked
☐ Drove left of center	☐ Pedestrian Error	☐ Improper lane change	☐ Slowing	☐ Other
☐ Improper overtaking	☐ Inadequate brakes	☐ Improper backing	☐ Backing	
☐ Avoid no contact vehicle	☐ Defective moving vehicle	☐ Alone		
	☐ Defective steering	☐ Was stopped before braking		

DRIVER

DRIVER OR PEDESTRIAN SOBRIETY (Check One or More for Each)	DRIVER OR PEDESTRIAN PHYSICAL CONDITION (Check One or More For Each)
☐ Consumed Alcohol	☐ Fatigue-Asleep ☐ Medication
☐ Consumed Controlled Substance	☐ Eyesight Imp. ☐ Amputee
☐ Had Not Consumed Alcohol	☐ Hearing Imp. ☒ No App. Defects
☒ Sobriety Unknown	☐ # ☐ Other physical impairment*
☐ Consumed Medication	
☐ Tested by Instrument	*Specify
☐ Field Sobriety Test	
☐ Eye Gaze/Nystagmus	

PEDESTRIAN

PEDESTRIAN ACTION	
At Intersection	Not at Intersection
☐ With signal	☐ Was behind traffic
☒ Against signal	☐ No crosswalk
☐ No signal	☐ Crosswalk
☐ Disposal	☐ Walking W/ tr.
	☐ Other*
	☐ Walk against
	☐ Standing
	☐ Pushing or Working on vehicle
	☐ Playing in road
	*Specify

Diagram Drawn by: Officer Michael Thomas | Measurements By: Officer Michael Thomas | Leave Blank

DIAGRAM **REFER TO SUPPLEMENTAL DIAGRAM.**

☐ Indicate North by Arrow

Use Supplemental Diagram/Narrative Sheet for additional information

NARRATIVE (Describe how accident occurred) **REFER TO SUPPLEMENTAL NARRATIVE**

TRAILER OR TOWED VEHICLES	TOWED BY VEH. # 1	Year	Make	Lic. Yr. - State - Number	Type
		1999	Dorsey	2002 TN 003234T	D3
	TOWED BY VEH #	Year	Make	Lic. Yr. - State - Number	Type

ENFORCEMENT ACTION

VEH. NO.	Name	Violation	W	S	C	Citation No.
	NONE		☐	☐	☐	
VEH. NO.	Name	Violation	W	S	C	Citation No.
			☐	☐	☐	
VEH. NO.	Name	Violation	W	S	C	Citation No.
			☐	☐	☐	

Time Notified	Time Arrived	Notified By	Supvr. at Scene	Checked By
18:43 HOURS	18:51 HOURS	Las Cruces SP	NONE	L Stanbery

Officer's Signature: Officer Michael Thomas | Bank: PTLM | ID No.: 1911 | District: 12 | Date of Report: 10-17-02

THIS REPORT MAY CONTAIN OPINIONS AND OBSERVATIONS OF THE INVESTIGATING OFFICER

SHTD- 18076
REV. 7/90

STATE OF NEW MEXICO UNIFORM ACCIDENT REPORT
SUPPLEMENTAL DIAGRAM/NARRATIVE

Date	Time	Location	County
10/16/02	1840	Interstate 10 mm 93.3	Luna
Driver No. 1			Sheet
Stout, Jason L.			3
Driver No. 2			Of
N/A			6

On October 16, 2002, at approximately 18:40 hours, an accident occurred on Interstate 10 at mile marker 93. This accident involved a white 2001 Volvo tractor-trailer. The tractor-trailer had been traveling eastbound when it suddenly went into the median and over turned.

Upon my arrival at the scene I observed the tractor-trailer in the median laying on it's drivers side pointing north. The driver, Jason Strout, was located on the ground under the driver's side rear tractor tires. The driver appeared to be deceased; Deming City Ambulance personal confirmed this. The passenger, Robert Knight, was later located under the drivers side of the sleeper of the tractor. Both the passenger and driver were pronounced deceased at the scene by Medical Investigators Fred Rossiter and Carl Bennett.

The witnesses, Natasha Welch and Veronica, were traveling together and they advised that they had been eastbound in the left lane traveling at 65 mph when the tractor-trailer passed them in the left lane. The tractor-trailer the then changed lanes into the left lane in front of them. The tractor-trailer then suddenly went in to the median and overturned. They advised that there was no traffic in front of the tractor-trailer before it went into the median. They also stated that she could see no reason the tractor-trailer to go off the road and that it did not appear to by speeding. The witnesses were interview by Officer Chad Casson NMSP.

Investigation of the scene and the vehicle showed that the tractor-trailer had been eastbound in the right lane when it suddenly went across the left lane; this was indicated by tire marks left on the roadway. Then tractor-trailer started into the median in a broadside side skid with the passenger side leading. The tractor-trailer was partly in the median when it started to overturn. It overturned onto its passenger's side with tractor and the front portion of the trailer in the median and the rear portion of the trailer on the roadway. The tractor-trailer slid on it's passenger side until it was entirely in the median where it continued to overturn until it came to rest on it's drivers side. The tractor-trailer rolled over 3/4 times. While the tractor-trailer was overturning both occupants were ejected. The driver was not wearing a safety belt. The passenger was in the sleeper portion of the tractor and he was ejected when the roof of the sleeper came off during the rollover. The driver came to rest under the driver's side rear wheels of the tractor and the passenger came to rest under the driver's side sleeper.

Tire marks left on the roadway by the tractor-trailer indicates that vehicle went from the right lane across the left lane and off the median very suddenly. The distance from the start of the tire marks to where the vehicle first entered the median was 121 feet. This type of sudden swerving of the vehicle is not indicative of driver inattention as a possible cause of the accident.

Inspection of the vehicle tires showed that the driver side tires were not damaged. The passenger side front and outside duel tires were deflated. The deflated tires were not damaged and appeared to have become deflated when the vehicle was rolling over.

Motor Transpiration Division Officer Jerry Masoner conducted a Level 2 commercial vehicle inspection of the tractor-trailer at the scene. A copy of his inspection is attached to this report.

On October 18, 2002, at 18:00 hours, Officer Jerry Masoner and I went to the M & D Towing storage facility in Deming, NM. and inspected the steering and front axle components of the tractor. The front axle had become dislodged from the tractor during the accident. The steering box appeared to be undamaged. The four U-bolts holding the front axle had broken allowing the axle to become dislodged. Inspection of the broken U-bolts showed that the passenger side bolts had each broken on one end and the break was straight across the bolt at the end of the threads.

Continued on next page.

Officer Michael Thomas

SHTD-10076
REV. 2/98

STATE OF NEW MEXICO UNIFORM ACCIDENT REPORT
SUPPLEMENTAL DIAGRAM/NARRATIVE

The driver side out side bolt was broken on one end; the inside bolt was missing. The outside bolt was broken at front-end one end and the break was at an angle through the treaded portion. This type of angled break could indicate metal fatigue. The boltholes were inspected and they appeared to be straight except for the outside front bolthole on the driver side. The driver side front outside bolthole appeared to be oblong on the front out side of the hole. This oblong bolthole could indicate wear from bolt movement.

The cause of this accident remains undetermined. Further investigation into the possibility of mechanical failure will be conducted. Supplemental reports to this report will be filed as additional information is developed.

Narrative By: Officer Michael Thomas

Driver No. 1	Interstate 10 mm 98.3
Stout, Jason L.	
Other No. 2	
N / A	

Street	4
	B

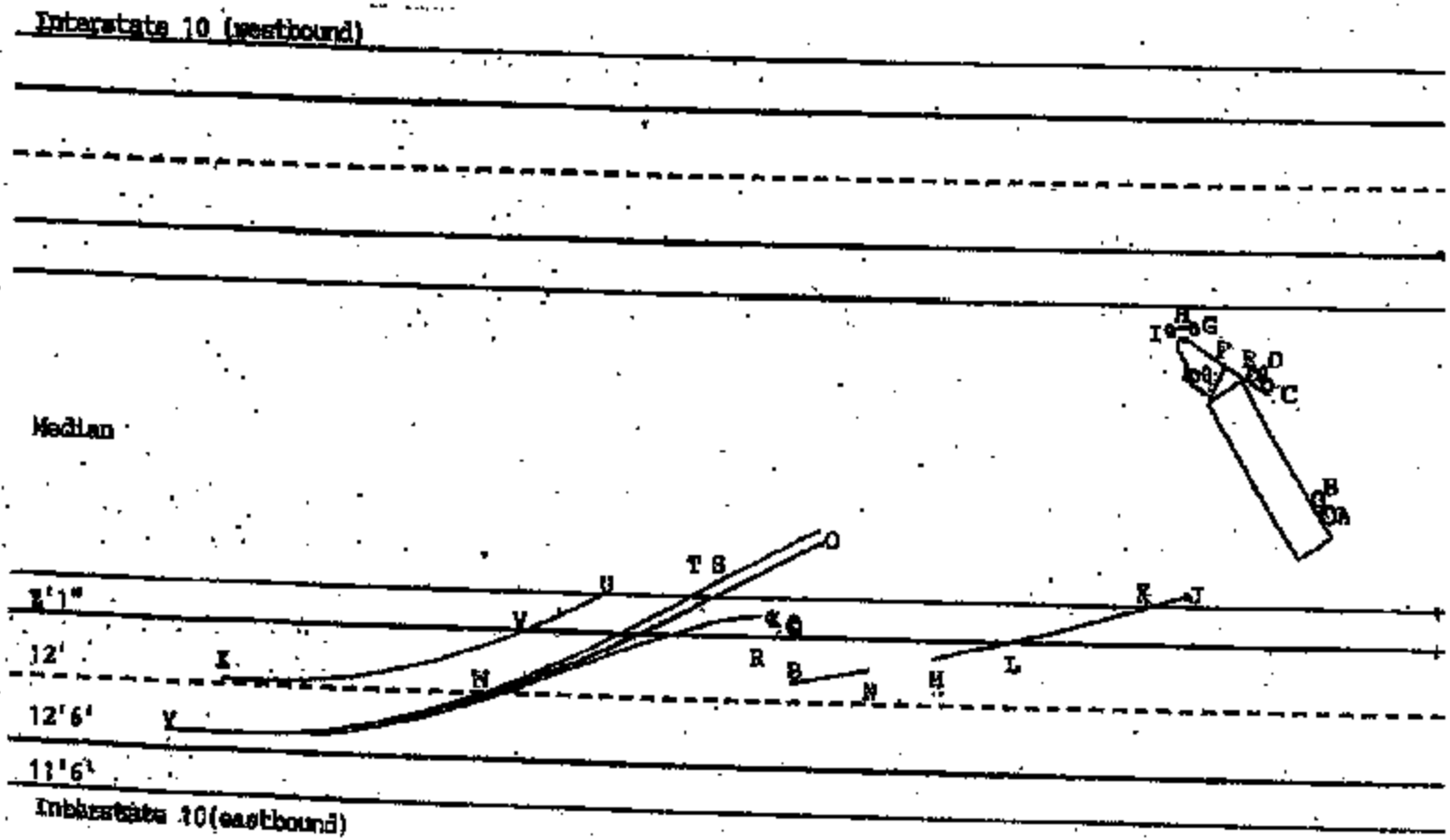
2/10/03	1040	Interstate 10 mm 93.3	Luna
Driver No. 1 Stout, Jason L.			Sheet 5
Driver No. 2 N/A			of 8

Diagram By: Officer Michael Thomas

THIS DIAGRAM IS NOT TO SCALE.

The reference points are located west edge of the overpass.

SUPPLEMENTAL DIAGRAM/NARRATIVE



TD- 10078
R. 7/90

STATE OF NEW MEXICO UNIFORM ACCIDENT REPORT
SUPPLEMENTAL DIAGRAM/NARRATIVE

10/19/02	1640	Interstate 10 mm 93.3	Luna
Driver No. 1 Stout, Jason L.			
Driver No. 2 N/A			
		ID 8	Sheet 6

Diagram Legend

Points of Interest	Reference Point (1)	Baseline
A- Second axle, left side tire of trailer (Point of Rest)	445' 4"w	64'11"s
B- First axle, left side trailer tire (Point of Rest)	450'1"w	60'6"s
C- Second rear axle, left side tire of tractor (Point of Rest)	474'4"w	33'9"s
D- Driver (Point of Rest)	476'4"w	31'5"s
E- First rear axle, left side tire of tractor (Point of Rest)	479'7"w	31'9"s
F- Passenger (Point of Rest under tractor)	486'4"w	41s
G- Right front tire of tractor (axle dislodged)	494'7"w	24'4"s
H- Left front corner of tractor	498'0"w	26'10"s
I- Right front tire of tractor (axle dislodged)	510'0"w	26'8"s
Points of Interest	**Reference Point (2)**	**Baseline**
J- End of rear corner gouge mark from trailer	498'7w	9'3"n
K- Gouge mark from trailer leaves the roadway	499'9"w	7'6"n
L- Gouge mark from trailer crosses edgeline	563'4"w	0
M- Gouge mark from trailer restarts	574'9"w	5'1"s
N- Gouge mark from trailer ends	606'5"w	8'0"s
O- Tire mark ends in the median	618'7"w	27'7"n
P- Gouge mark from trailer starts	626'10"w	10'4"ss
Q- Rim impact mark	637'7"w	3'11"n
R- Tire mark on median shoulder ends	639"11w	3'10"n
S- Tire mark leaves the roadway	660'8"w	7'0"n
T- Tire mark leaves the roadway	667'8"w	7'0"n
U- Tire mark leaves the roadway	688'2"w	7'0"n
V- Tire mark crosses the edgeline	714'8"w	0
W- Tire marks cross centerline	730'0"w	11'10"s
X- Start right side tire mark	791'1"w	12'2"s
Y- Start of left side tire mark	809'7"w	20'11"s

The Reference Point (RP) is located at the west edge of overpass at mile marker 93.
Measurements By: Officer Michael Thomas.

Accident Report #

Date: 10-16-02

STATE OF NEW MEXICO – MOTOR TRANSPORTATION DIVISION

TRUCK AND BUS SUPPLEMENTAL ACCIDENT REPORT

ONLY COMPLETE THIS FORM IF TWO CONDITIONS ARE MET

ACCIDENT MUST HAVE INVOLVED	AND AT LEAST ONE OF THE FOLLOWING OCCURRED:
Condition #1: ☒ A truck with GVWR more than 10,000 pounds; and/or ☐ A vehicle with Hazmat placarding; or ☐ A bus with seats for more than 8 people (including the driver)	Condition #2: ☒ Person(s) fatally injured. ☐ Injured person(s) taken from the scene for medical attention. ☐ Vehicle(s) towed from the scene.

CARRIER INFORMATION

Carrier Name: Commodor Express Inc.	CARRIER ID:
Carrier Address: P.O. Box 507	US DOT # 00728634
Carrier City: Antioch, TN 37011	ICC MC # 333606
Carrier State: Tn. Colonia (Mexico):	State Name/
Carrier Zip: 37011 ☐ No ☒ Yes	State Carrier #

VEHICLE INFORMATION

- ☐ Passenger Car – only record when vehicle displays a Hazardous Material placard
- ☐ Light truck (van, mini-van, panel, pickup, sport utility vehicle) – only record when vehicle displays an HM placard
- ☐ Bus (seats for 9 – 15 people, including driver)
- ☐ Bus (seats for more than 15 people, including driver)
- ☐ Single-unit truck (2-axle, 6-tire)
- ☐ Single-unit truck (3-or-more axles)
- ☒ Truck/Trailer
- ☐ Truck Tractor (bobtail)
- ☐ Tractor/Semi-trailer
- ☐ Tractor/Doubles
- ☐ Tractor/Triples
- ☐ Unknown Heavy Truck > 10,000 lbs., Cannot Classify

- ☐ Bus (seats for 9 - 15 people, including driver)
- ☐ Bus (seats for more than 15 people, including driver)
- ☒ Van/Enclosed Box
- ☐ Cargo Tank
- ☐ Flatbed
- ☐ Dump
- ☐ Concrete Mixer
- ☐ Auto Transporter
- ☐ Garbage/Refuse
- ☐ Grain, chips, gravel
- ☐ Pole
- ☐ Not applicable
- ☐ Other

ACCIDENT INFORMATION

1 2 3 4	Noncollision: Ran Off Road
1 2 3 4	Noncollision: Jackknife
1 2 3 4	Noncollision: Overturn (Rollover)
1 2 3 4	Noncollision: Downhill Runaway
1 2 3 4	Noncollision: Cargo Loss or Shift
1 2 3 4	Noncollision: Explosion or Fire
1 2 3 4	Noncollision: Separation of Units
1 2 3 4	Noncollision: Cross median/centerline
1 2 3 4	Noncollision: Equipment Failure (brake failure, blown tires, etc.)
1 2 3 4	Noncollision: Other
1 2 3 4	Noncollision: Unknown
1 2 3 4	Collision involving Pedestrian
1 2 3 4	Collision involving Motor Vehicle in Transport
1 2 3 4	Collision involving Parked Motor Vehicle
1 2 3 4	Collision involving Train
1 2 3 4	Collision involving Pedalcycle
1 2 3 4	Collision involving Animal
1 2 3 4	Collision involving Fixed Object
1 2 3 4	Collision with work zone maintenance equipment
1 2 3 4	Collision with other movable object
1 2 3 4	Collision with unknown movable object
1 2 3 4	Other – see supplemental

- ☐ Two-way, not divided
- ☒ Two-way, divided, unprotected median
- ☐ Two-way, divided, positive median barrier
- ☐ One-way, not divided
- ☐ Unknown

☒ Full Access Control ☐ Partial Access Control ☐ No Access Control

Does Vehicle Contain Hazardous Materials Placard? ☒ No ☐ Yes

Was Hazardous Cargo Released From the Vehicle? ☒ No ☐ Yes

Four Digit Placard Number N / A

One-digit Placard Number From Bottom of Diamond ____

Name of Hazardous Material: N / A

- ☐ Less than or equal to 10,000 pounds
- ☐ 10,001 – 26,000
- ☒ More than 26,000 pounds

Enforcement

Citation Issued (to Truck or Bus Driver) as a result of the Crash? ☒ No ☐ Yes ☐ Pending

Miscellaneous

Road Surface Condition: Weather Condition:

Standing/Moving Water? ☒ No ☐ Yes Sleet, Hail? ☒ No ☐ Yes

Slush? ☒ No ☐ Yes

MSC000

lew Mexico DPS - Motor Transportation Division
.O. Box 1628
anta Fe, NM 87507-1628
hone: (505)827-0390 Fax: (505)827-0518

DRIVER VEHICLE EXAMINATION REPORT
Report Number: NM4001100251
Inspection Date: 10/16/2002
Start Time: 7:12 PM End Time: 8:02 PM
Insp. Level: 2-Walk-Around No HM Insp.

OMMODORE EXPRESS INC
O BOX 507
NTIOCH, TN 37011
hone#:
SDOT#: 00728634
ate#:
Fax#:
ICC#: 333806

Driver: STOUT, JASON L
License#: 8330432772B9 State: IL
Date of Birth: 08/21/1977
CoDriver: KNIGHT JR, ROBERT T
License#: 48676725 State: TN
Date of Birth: 03/28/1958

ocation: DEMING
ighway: I-10
ounty: LUNA
MilePost: 96
Origin: MARICOPA AZ
Destination: GOODLETTSVILLE TI
Shipper: SANTA ROSA COOLING
Bill of Lading: U03280
Cargo: Fresh Produce

EHICLE IDENTIFICATION

Unit	Type	Make	Year	State	License #	Company #	Vin #	GVWR	CVSA #	OOS#
1	TT	VOLV	2001	TN	58287HY					
2	ST	DORS	1999	TN	008234T	53677				

RAKE ADJUSTMENTS: No Brake Inspection Required For Level 2-Walk-Around,

IOLATIONS: No Violations Were Discovered.

az Mat: No HM Transported. **Placard:** No **Cargo Tank:**

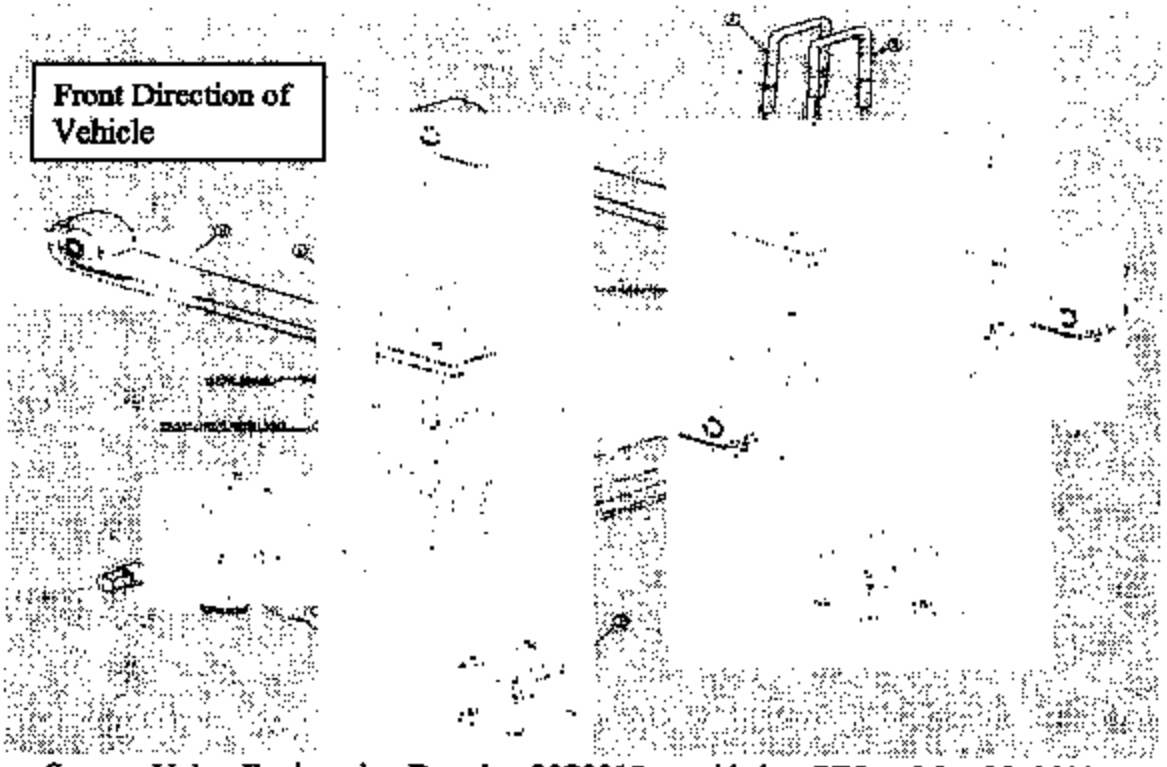
pecial Checks: Post Crash

lechanic Certify Text
Signature Of Repairer X:_____ Facility:_____ Date:_____

arrier Verify Text
Signature Of Motor Carrier X:_____ Date:_____

port Prepared By: RY MASONER
Badge #: 2705
Copy Received By: STOUT, JASON L.
X_____
Page 1 of 1
NM4001100251

Appendix B – Drawing of Volvo Front Suspension System

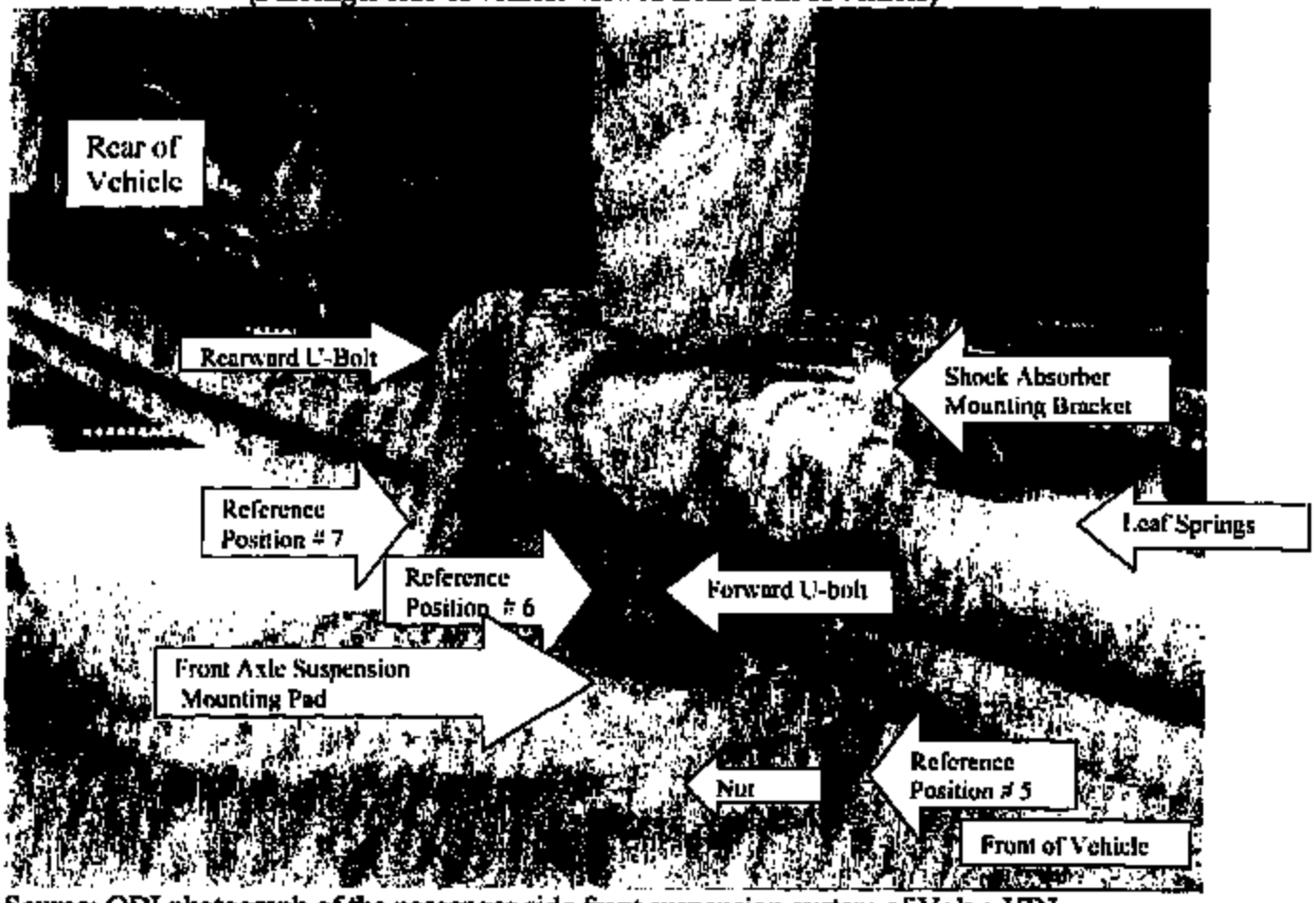


Source: Volvo Engineering Drawing 8080317 provided to ODI on May 20, 2003 in response in ODI Information Request. ODI has edited the sketch for this report.

Appendix C -

Photograph of Representative Volvo Front Suspension Retention System

(Passenger side of vehicle viewed from front of vehicle)



Source: ODI photograph of the passenger side front suspension system of Volvo VIN 4V4NC9JH51N317996 on April 30, 2003 taken at the Ryder facility in Albuquerque, NM.